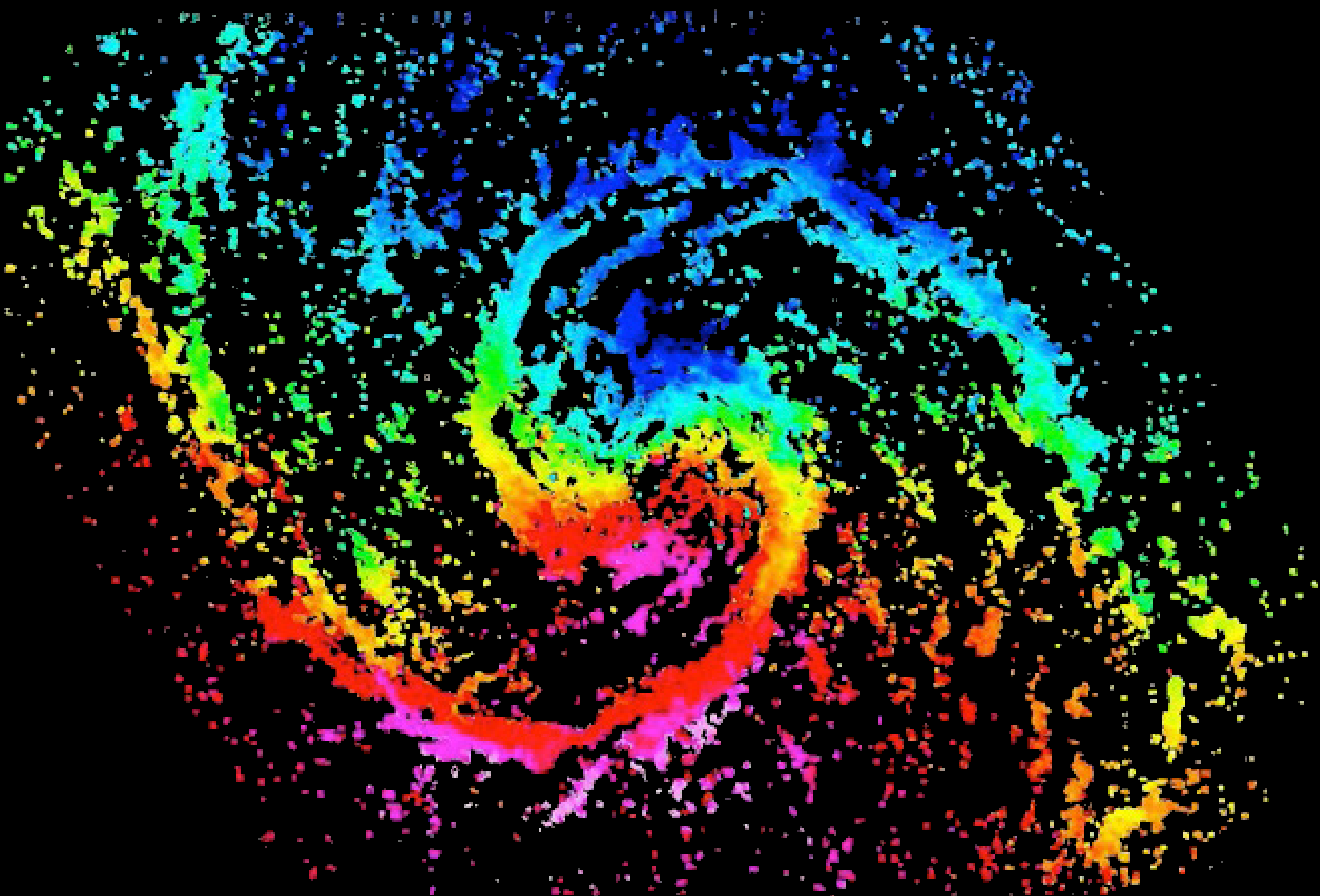
IRAM Annual Report 2011



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Millimétrique

IRAM Annual Report 2011

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Introduction

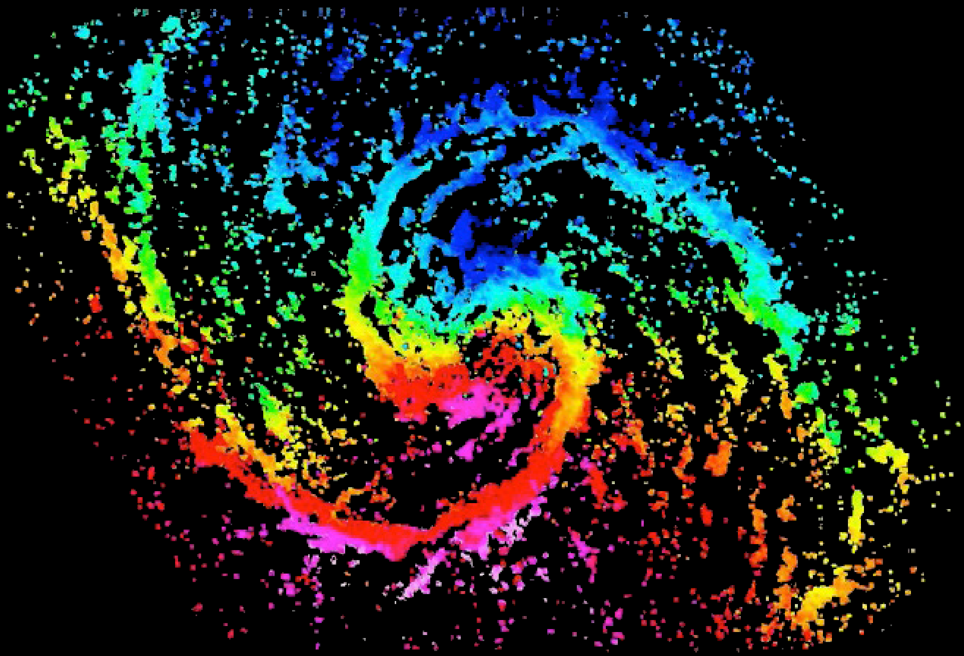
The year 2011 has seen very important decisions of the IRAM partners CNRS, MPG and IGN for the future of IRAM and therefore also for a large part of European excellence in millimeter radio astronomy. The partners have decided to prolong their fruitful collaboration within IRAM up to at least 2024 and at the same time gave green light for the first and most important phase of the NOEMA project with the related financial support.

With these decisions the IRAM associates have laid out a solid basis for the future of IRAM and the role it will play while ALMA starts operation.

All throughout 2011 the IRAM users, with the help of the IRAM observatories, have produced outstanding scientific results which underline the importance of millimeter wave observations in modern astronomy. The IRAM community will thus be extremely well prepared to work on the wealth of data which are now available from HERSCHEL and Planck but also very soon from ALMA.

Meanwhile IRAM has continued to improve the instruments at the facilities beyond the standards of most other observatories working at the same wavelength range. With the excellent motivation of scientific and technical IRAM staff, development of advanced millimeter wavelength technology will not stop in any foreseeable future but ground breaking instrumentation will be made available be it in form of imaging systems for the 30m telescope or of very wide band systems for NOEMA.

Pierre Cox
Director

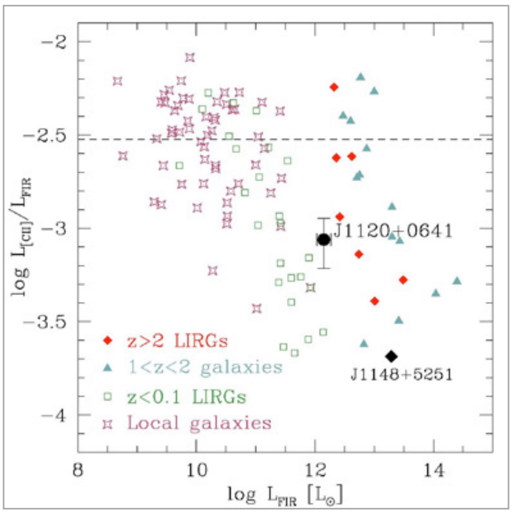


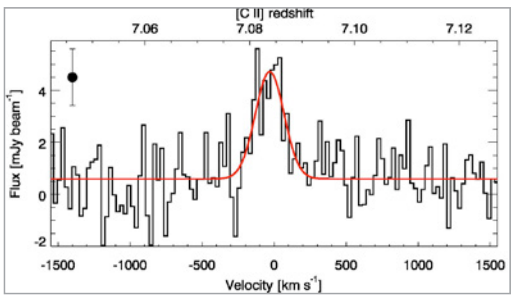
Highlights of research with the IRAM telescopes in 2011

LUMINOUS GAS AND DUST AT REDSHIFT 7

Understanding the formation of the earliest quasars and host galaxies is a subject of considerable interest since the discovery of the bulge-mass black-hole-mass correlation in nearby galaxies, a result that led to the suggestion of a fundamental relationship between massive black holes and spheroidal galaxy formation. To further constrain the build-up of massive galaxies at the earliest cosmic epochs, it is important to perform these comparisons directly at the highest redshifts, where the physical processes are caught in the act.

Using the IRAM interferometer, Venemans (MPIA/ESO) and coauthors reported the detection of the 158 µm [CII] emission line and underlying dust continuum in the host galaxy of the quasar ULAS J112001.48+064124.3 at *z*=7.0842+/-0.0004. This is the highest redshift detection of the [CII] line to date, and allowed Venemans to put first constraints on the physical properties of the host galaxy. The [CII] line luminosity is ~1.2 10^9 $L_\odot$, which is a factor ~4 lower than observed in SDSS J1148+5251 at *z*=6.42. The underlying FIR continuum has a flux density of ~0.6 mJy, similar to the average flux density of redshift 6 quasar and implies a star-formation rate in the range 160-440 $M_\odot$/yr and a total dust mass of ~9 10^7 $M_\odot$ in the host galaxy. Noteworthy, the [CII] line is among the narrowest observed (~250 km/s) when compared to the molecular line widths detected in redshift 6 quasars. Both the [CII] and dust continuum emission are spatially unresolved at an angular resolution of 2.0″ x 1.7″ (about ~90 kpc^2 at the distance of ULAS J112001.48). The dynamical mass of the host implied by the observed line width is M_{dyn} < 1.4 10^{11} $M_\odot$. If the bulge mass is close to the dynamical mass, then the black-hole bulge mass ratio is >10 times higher than observed in local galaxies.



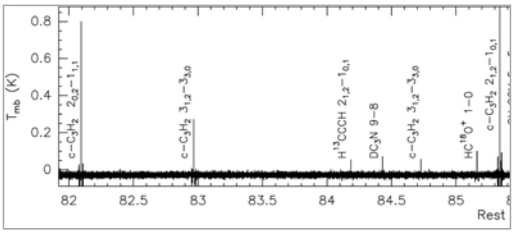


Spectrum of the redshifted [C II] 158 µm line plus continuum of ULAS J112001.48+064124.3 (left), ratio of [C II] luminosity over FIR luminosity as a function of FIR luminosity (right).
Work by Venemans et al., 2012, ApJ in press.

COLD CORE CHEMISTRY UNRAVELED

Star formation begins with the gravitational collapse of over-dense cold molecular clouds. To constrain the chemistry in clouds that offers the opportunity to reach scales by which to separate individual collapsing starless cores, Frau (CSIC/IEEC) and collaborators have managed to observe the Pipe nebula, a nearby (145 pc) region that harbors more than one hundred low-mass ~1 $M_{\odot}$ starless cores. The Pipe nebula differs from the other nearby dark cloud complexes, such as Taurus or ρ Ophiucus, because of much lower star formation efficiency. It is therefore an ideal target for studying the physical and chemical conditions in a pristine environment prior to the onset of the star formation processes.

Frau and collaborators were among the first to use the new IRAM 30-m FTS (Fourier Transform Spectrometer, 2011) backend to perform one of the first unbiased 15 GHz wide spectral surveys at 3 mm on a sample of young diffuse starless cores in the Pipe nebula. They discovered an unexpectedly rich chemistry by which they were to propose a new classification based on the emission of molecular lines normalized by the core visual extinction (A_v). On the basis of their classification, Frau and collaborators defined three groups of starless cores: diffuse cores ($A_v \leq 15$) characterized by a lack of chemical richness and by the presence of species like CS and C2H, oxo-sulfurated cores ($15 \leq A_v \leq 22$) that appear to be abundant in species like SO, SO_2 and HCO, and deuterated cores ($A_v \geq 22$) with a rather evolved chemistry characterized by the presence of nitrogenated and deuterated species, as well as carbon chain molecules. The chemical probing basically suggests that the chemistry is far richer than expected for a cloud giving birth to low-mass stars at very low efficiency.



Zoom on the Pipe Nebula (Credit ESO/Beletzski) and yellow circle centered on core 12 (top), 15 GHz full bandwidth spectrum observed with the FTS at the IRAM 30m telescope towards core 12 (bottom).
Work by Frau et al., 2012, AA, 537, L9

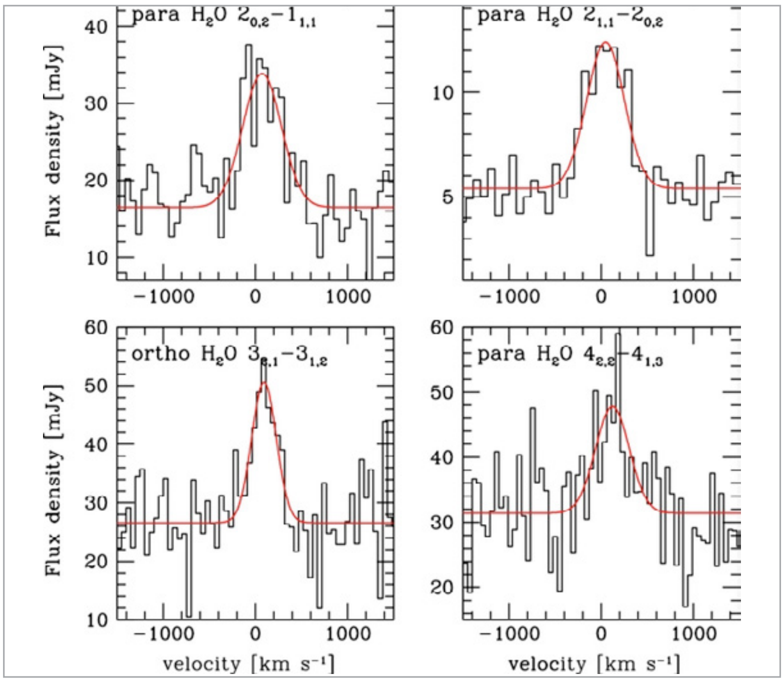
WATER IN THE EARLY UNIVERSE

Water is expected to be one of the most abundant molecules in molecular clouds. While in cold molecular clouds, water is in the form of icy mantles on dust grains, in warm molecular clouds, such as in star forming galaxies or galaxies with a luminous active galactic nucleus, water can evaporate from the dust grains when the grain temperature becomes sufficiently high.

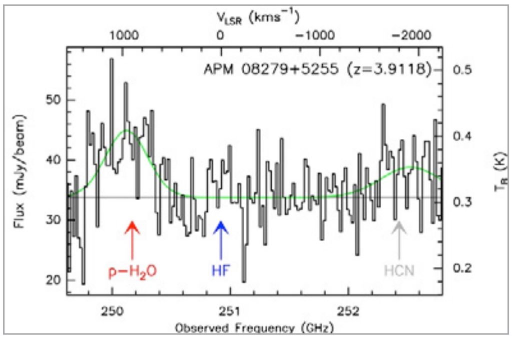
Due to the wet Earth atmosphere, bulk gas-phase water can only be detected from space or from distant objects where the cosmological redshift moves the water lines into transparent atmospheric windows. Despite a recent detection of water at redshift 2.6, searches for non-maser rotational emission lines of water from the highest-redshift galaxies remained unsuccessful.

In 2011, two teams of astronomers used the IRAM interferometer to observe the host galaxy of the redshift 3.911 QSO APM08279+5255. While the team led by Lis (Caltech) reported the serendipitous

Spectra of water emission lines from the host galaxy of APM08279+5255 (Van der Werf et al. 2011)
Work by Van der Werf et al. ApJ, 2011, 741, L38



Spectrum of the $2_{2,0}$-$2_{1,1}$ transition of water (Lis et al. 2011).
Work by Lis et al. ApJ, 2011, 738, L6



detection of the $2_{2,0}$-$2_{1,1}$ transition, the team of Van der Werf (Leiden Observatory) reported the successful observations of the $2_{2,0}$-$2_{1,1}$, $2_{1,1}$-$2_{0,2}$, $3_{2,1}$-$3_{1,2}$ and $4_{2,2}$-$4_{1,3}$ transitions of water.

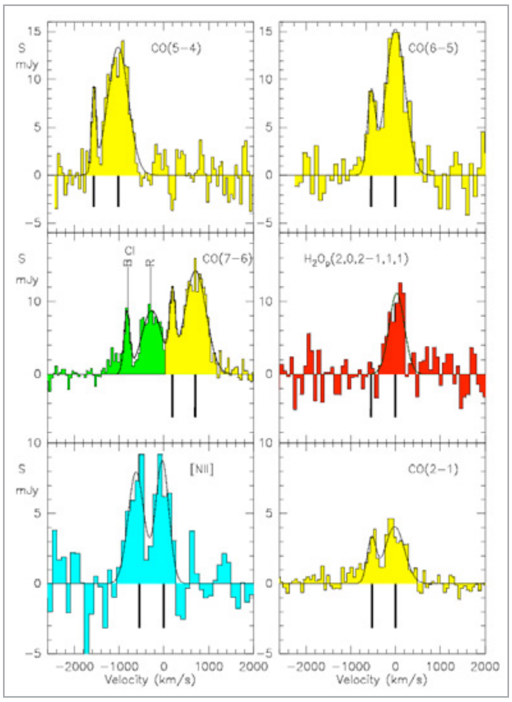
Van der Werf and coauthors proposed a model for APM08279+5255, where the infrared-opaque circumnuclear cloud, which is penetrated by the X-ray radiation field of the QSO nucleus, contains clumps of massive star formation where the water emission originates. They find that while the lowest water transitions are collisionally excited in clumps of warm, dense gas (density of hydrogen nuclei n_H ~3 10^6 cm^{-3}, gas temperature T_g ~105 K), the excitation of the higher water transitions is dominated by the intense local infrared radiation field. Since only collisionally excited emission contributes to gas cooling, they conclude that water is not a significant coolant of the warm molecular gas.

A HYPER-LUMINOUS GALAXY, ONE BILLION YEARS AFTER THE BIG-BANG

Because of their large distance and very weak luminosity, it is very difficult to detect primordial galaxies. The gravitational amplification by foreground galaxy clusters is therefore used to increase the apparent luminosity of these galaxies and the chances to discover them. The bulk of their energy of these galaxies is emitted in the very far infrared by dust heated by large populations of young massive stars.

In the frame of the Herschel Lensing Survey (HLS) of massive galaxy clusters, Combes (LERMA) and collaborators have discovered an exceptionally bright source behind the *z*=0.22 cluster Abell 773. The source, which appeared to be a strongly lensed submillimeter galaxy (SMG), is unusual compared to most other lensed sources discovered by Herschel, because of its flux density (~200 mJy at 500 µm) and redshift (*z*=5.2429). The dominant lens is a foreground *z*=0.63 galaxy, not the cluster itself. The source has a far-infrared (FIR) luminosity of L_{FIR}= 1.1 10^{14}µ L⊙, where µ~11 is the magnification factor.

The CO(5-4), CO(6-5), p-H_2O (2_{02}-1_{11}) and [NII]) lines are from the IRAM 30m telescope, the CO(7-6) and CI/($^3P_2$-$3P_1$) are from the IRAM PdBI and the CO(2-1) is from the EVLA. Work by Combes et al., 2012, AA, 538, 4



Combes reported the redshift identification through CO lines with the IRAM 30m telescope, and the analysis of the gas excitation, based on CO(7-6), CO(6-5), CO(5-4) detected at IRAM and the CO(2-1) at the EVLA. All lines decompose into a wide and strong red component, and a narrower and weaker blue component, 540 km/s apart.

The authors derive an H_2 mass of 5.8 10^{11}µ M⊙, of which one third is likely to be in a cool gas component. From the CI line they derive a CI/H_2 number abundance of 6 10-5 as found in other ULIRGs. The water line is found to be strong only in the red velocity component, with an intensity ratio I(H_2O)/I(CO) ~0.5, suggesting a strong local FIR radiation field, possibly from an active nuclear component.

The authors also report the highest redshift detection of the [NII] 205 µm. The line shows comparable blue and red components, with a strikingly broad blue component, suggesting strong ionized gas flows.

The system, even when the amplification factor is taken into account, is hyper-luminous (>10^{13} L⊙, or 2-3 orders of magnitude more than the Milky Way), which is remarkable for an object formed only one billion years after the Big-Bang.

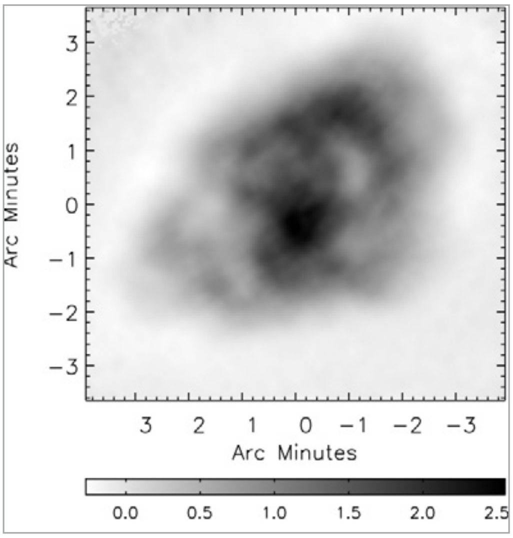
GISMO'S LOOK AT THE CRAB NEBULA

The Crab Nebula is the prototypical example of a pulsar wind nebula, a so-called plerion or filled-center supernova remnant. As one of the brightest objects in the sky across the entire electromagnetic spectrum from the radio to gamma rays, the Crab Nebula is often one of the first targets observed by new instruments, whether they provide new spectral windows, or offer improvements in sensitivity or spatial or spectral resolution. To assess the performance of GISMO (Goddard-IRAM Superconducting two-Millimeter Observer) bolometer camera at the IRAM 30m telescope, observations were performed that probe the 2mm emission of the synchrotron radiation of the Crab Nebula.

At radio wavelengths the integrated emission from the Crab Nebula is known to follow a power-law spectrum $\sim\nu^{-0.3}$, typical of the synchrotron emission exhibited by pulsar wind nebulae, and distinctly flatter than the spectral indices of more common shell-like SNRs where the relativistic electrons are accelerated in the shocks of the expanding blast wave rather than by a pulsar wind.

To investigate and compare the synchrotron emission of the Crab Nebula at different wavelengths, Arendt (CRESST/NASA) and collaborators observed the Crab Nebula with GISMO at 2mm. They found that the integrated flux density is consistent with the radio power-law spectrum, extrapolated up to a break frequency in the 350 to 1300 GHz range. So far, the GISMO data and their analysis support earlier conclusions according to which the integrated spectrum of the Crab Nebula continues as a power law from the radio regime down to wavelengths <850 µm.

Comparison to radio data at comparable spatial resolution enables the authors to confirm significant spatial variation of the spectral index between 21 cm and 2 mm. They argue that the main effect is a spectral flattening in the inner region of the Crab Nebula and that the regions of flattest spectral index appear to be well correlated with the torus in the central region of the nebula, as seen at IR and X-ray wavelengths.



GISMO map of the Crab Nebula at 2 mm, smoothed to about 20" resolution. *Work by Arendt et al., ApJ, 2011, 734, 54*

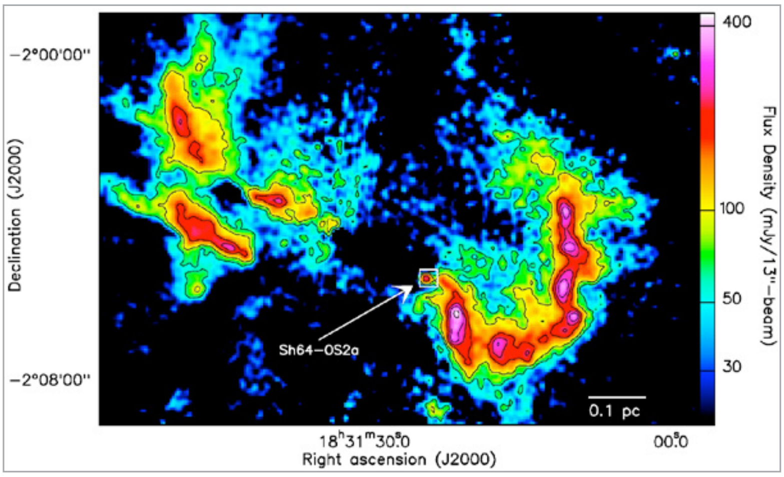
The authors also confirm the millimeter–radio spectral index variations observed by Green et al. (2004) and Bandiera et al. (2002), but as they derive the same spectral index variations when comparing to radio data from two different epochs, they conclude that temporal variations in the synchrotron emission near the pulsar may be responsible for the flatter spectral index in the region.

Finally, they do not confirm the flux excess observed by Bandiera et al. (2002) who concluded to the existence of a second, distinct synchrotron component generated by a separate population of relativistic electrons.

HIGHLY ACTIVE PROTOCLUSTERS IN THE AQUILA RIFT

While most stars are believed to form in stellar clusters, the formation and early evolution of young stellar clusters is still largely unknown. Improving our knowledge of the earliest phases of clustered star formation is crucial for understanding the origin of the stellar initial mass function and the efficiency of the star formation process, which both play a key role in the evolution of galaxies. Maury (ESO/Garching) and collaborators present an analysis of the Aquila rift complex which addresses the questions of the star formation rate (SFR), star formation efficiency (SFE) and typical lifetime of the Class 0 protostellar phase in two nearby cluster-forming clumps: the Serpens South and W40 protoclusters.

MAMBO 1.2mm continuum map around the HII region W40.
Work by Maury et al. A&A, 2011, 535, A77



The authors carried out 1.2 mm dust continuum mapping observations of the Aquila rift complex with the MAMBO bolometer array at the IRAM 30 m telescope. Using a multi-scale source extraction method, they performed a systematic source extraction in the millimeter continuum maps. Based on complementary data from the Herschel Gould Belt survey and Spitzer maps, they characterized the spectral energy distributions (SEDs) of the 77 mm continuum sources detected and estimated their evolutionary stages. Taking advantage of the comprehensive dataset available for the Serpens South region, spanning wavelengths from 2 µm to 1.2 mm, they estimated the numbers of young stellar objects (YSOs) at different evolutionary stages and found a ratio of Class 0 to Class I protostars *N*(0)/*N*(I) = 0.19–0.27. This low ratio supports a scenario of relatively fast accretion at the beginning of the protostellar phase, and leads to a Class 0 lifetime of ~4–9 10^4 yr.

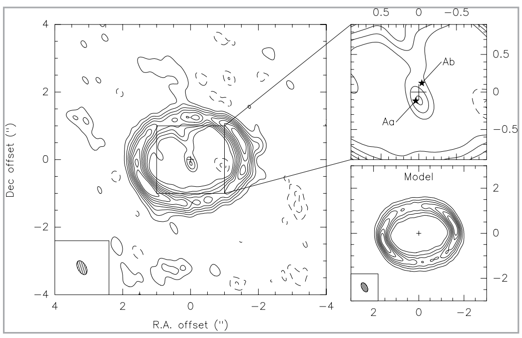
They also show that the W40 and Serpens South protoclusters in the Aquila rift are characterized by large fractions of protostars and SFRs of 20–50 $M_{\odot}Myr^{-1}pc^{-2}$, in agreement with the idea that these two nearby clumps are active sites of clustered star formation currently undergoing bursts of star formation, and have the potential ability to form bound star clusters.

While the formation of these two protoclusters is likely to have been initiated in a very different manner, the resulting protostellar populations are observed to be very similar. This suggests that after the onset of gravitational collapse, the detailed manner in which the collapse has been initiated does not affect much the ability of a clump to form stars.

REVISITING GG TAU'S CIRCUMBINARY DISK

The study of circumbinary disks is a key to understanding the formation mechanism and the evolution of binary stars. While optical or mid-infrared images are sensitive to the scattered emission, measurements of the thermal dust emission are best done at millimeter wavelengths where the emission traces surface density and contrast with the star's photospheric emission is not problematic. To place new constraints, Piétu (IRAM/Grenoble) and collaborators have used the upgraded IRAM interferometer to bring into sharper view the circumbinary disk around GG Tau.

Left: 267 GHz high-resolution continuum image of GGTau. Top right: zoom of the inner 1" and position of the GG Tau A binary star as of 2008. Bottom right: modeled dust distribution.
Work by Piétu et al. 2010, A&A, 528, A81



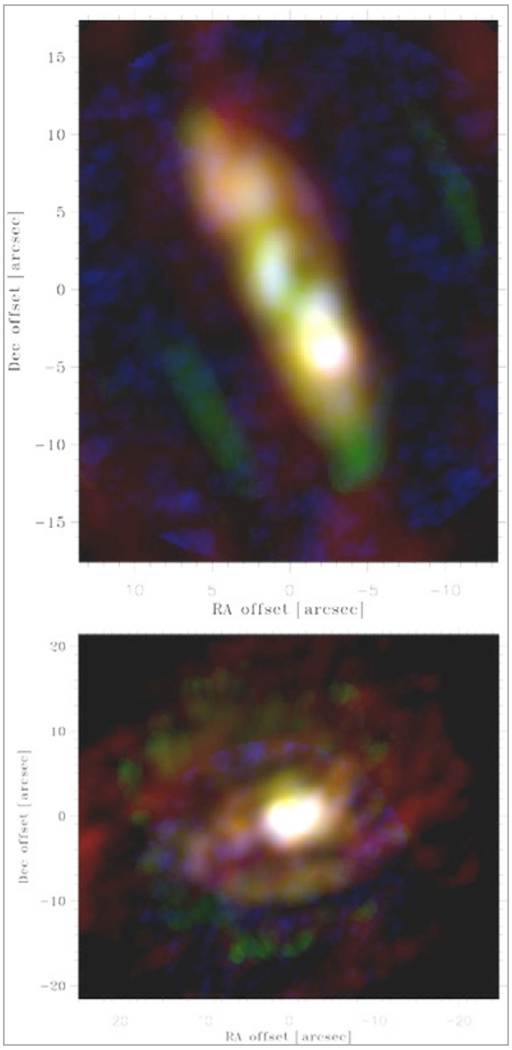
GG Tau is a well-known quadruple system located in the Taurus star-forming region. The northern system (GG Tau A) is a close binary with a separation of ~35 AU surrounded by a circumbinary disk. GG Tau A has been extensively studied by means of its visible or mid-infrared scattered emission and its dust emission in the millimeter domain. Earlier high angular resolution data clearly illustrated that the inner ~150 AU region of the disk has been emptied by tidal interactions between the two stars, making GG Tau one of the text-book examples of circumbinary disks around young stellar systems.

Observations by Guilloteau et al. (1999) in the ^{13}CO and HCO^+ lines already suggested that the disk is in Keplerian rotation around a ~1.3 $M_\odot$ system. Their data also indicated that the circumbinary disk around GG Tau A is composed of a ring (~70% of the mass) surrounded by a more extended, colder disk.

Piétu's recent observations of the millimeter continuum emission provided now a much sharper and deeper view on GG Tau A. The authors argue that the circumbinary dust emission is confined to a circular ring of width <50 AU, with very pronounced sharp edges. Their results place very tight constraints on theoretical model of the dynamical processes leading to the formation of rings in circumbinary systems. GGTau is 1.5 Myr old, but the observed ring is suspected to be a transient feature that will undergo significant evolution in the next Myrs.

INVESTIGATING THE PHYSICAL CONDITIONS IN TWO NEARBY ACTIVE GALAXIES

Multi-transition observations of the ^{12}CO molecule are essential for studying the processes at work in the centers of active galaxies. The molecular gas is likely to fuel the nuclear activity powered by intense star formation and/or by accretion onto a supermassive black hole. Conversely, the molecular gas properties are affected by the influence of the active nucleus through jets, winds, and radiation.



Composite color image of NGC4569 (top) and NGC4826 (bottom) made from the intensity maps of the CO(1-0), CO(2-1) and CO(3-2) line emission. The line intensities are represented by the red (IRAM), green (IRAM) and blue (SMA) color intensities, respectively.
Work by Boone et al. 2010, A&A, 525, A18

To characterize the physical conditions of the molecular environment in active galaxy and identify interstellar medium structures linked to star formation, shocks and quiescent gas reservoirs, Boone (LERMA) and collaborators have selected two nearby galaxies (NGC 4569 and NGC 4826) and observed them at high resolution in the (1-0) and (2-1) transitions with IRAM interferometer and in the (3-2) transition with the SMA. By combining the three transitions, the authors were able to compare the emission in the three lines and to map the line ratios, $R_{21} = I_{CO(2-1)}/I_{CO(1-0)}$ and $R_{32} = I_{CO(3-2)}/I_{CO(1-0)}$ at a linear resolution of ~160 pc for NGC4569 and ~40 pc for NGC4826. In both galaxies the emission in the three lines is similarly distributed spatially and in velocity, and CO is less excited ($R_{32} < 0.6$) than in the Galactic Center or the centers of other active galaxies studied so far.

According to a pseudo-LTE model, while the gas in NGC4569 is cold and optically thick in the (1–0) and (2–1) transitions, less than 50% of the gas is optically thin in the (3–2) line. LVG modeling also suggests the presence of an elongated ring of cold and dense gas coinciding with the inner Lindblad resonance (ILR) of the stellar bar in agreement with a previous analysis of the kinematics.

More excited gas is resolved in the circumnuclear disk of NGC4826. According to our pseudo-LTE model this corresponds to warmer gas with a ~20% of the (3–2) emission being optically thin. LVG modeling indicates the presence of a semicircular arc of dense and cold gas centered on the dynamical center and ~70 pc in radius. The gas temperature increases and its density decreases toward the center.

VARIABLE THERMAL SIO EMISSION IN THE L1148-MM OUTFLOW

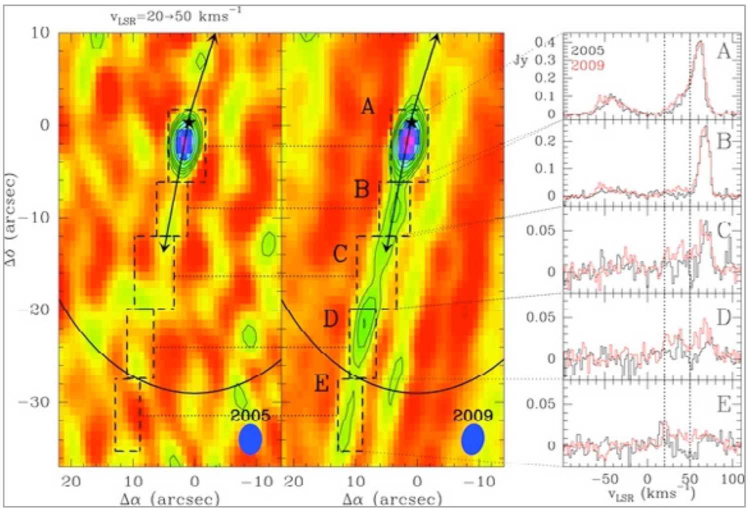
Variability is a common phenomenon in the evolution of young stars. Studies have shown that a high fraction of pre-main-sequence stars is showing active emission variability in the X-ray and optical/near-infrared. Likewise, young stellar objects are known to exhibit variability in their radio continuum emission on timescales of a few years. Though non-thermal maser emission has also been reported to show variability, no variability has ever been reported for thermal molecular emission.

Broad SiO thermal line emission being a good indicator of shocked gas in molecular outflows, Jiménez-Serra (CFA) and collaborators proposed that the narrow SiO line emission profiles stemming from the magnetic precursors within very young C-shock regions could evolve to the broader profiles generated in the intermediate- and high-velocity post-shock regions. As a consequence, they postulate variability of the SiO lines should appear within a few years only.

To prove their assumption, Jiménez-Serra et al. looked at high resolution maps of the thermal SiO v=0 J=2→1 emission observed towards the L1448-mm outflow in 2005 and 2009. The SiO maps of 2009 provide evidence for the appearance of new condensations at intermediate velocities (20–50 km/s) toward the redshifted lobe of the outflow. Though the authors think that toward one of the condensations (clump D) variability could be explained by systematic differences in the dirty beams of 2005 and 2009, they argue that the variability observed toward L1448-mm is due to an SiO enhancement by young C-shocks at the internal working surface between the jet and the ambient gas.

For SiO in the precursor regime (5.2–9.2 km/s), the authors detect several narrow and faint components. The narrow components tend to be compact, transient and show elongated bow-shock morphologies perpendicular to the jet.

Jiménez-Serra's PdBI images reveal that the SiO emission is variable in only 4 yr. Not only the morphology of the SiO emission but also its line profiles have changed significantly since 2005, with a clear increase of the SiO flux at intermediate velocities and possibly at high velocities. This suggests that new material has recently entered the shock.



SiO J = 2→1 emission from 20 to 50 km/s observed with the IRAM interferometer toward L1448-mm in 2005 (left) and 2009 (middle), and SiO spectra (right) averaged within condensations A, B, C, D, and E for the 2005 (black spectrum) and 2009 (red spectrum) epochs.
Work by Jiménez-Serra et al. 2010, ApJ, 739, 80

The 30-meter telescope

During 2011, more than 150 astronomers visited the observatory to conduct observations of their accepted projects or to support projects scheduled during the 13 weeks of pooled observations. The multiband, dual-polarization heterodyne receiver EMIR is heavily used by the astronomers, especially after the strong upgrades in bandwidths and backends conducted in 2011. A large part of the support work of the Granada staff was devoted to prepare for the handling of data from the 24 fast Fourier Transform Spectrometers (FTS) allowing to cover the instantaneous bandwidths of 32 GHz in total offered by EMIR. Support of test runs with the GISMO and NIKA prototype continuum cameras and improving on their integration into the 30m system, was another important activity in 2011.

UPGRADES OF THE EMIR RECEIVER

During the first week in November 2011, a major upgrade of the EMIR receiver was undertaken. The cryostat was removed from the receiver cabin and the whole RF and optical sections of the 1.3mm and 0.8mm bands (E230 and E230) were replaced by 8 GHz wide 2SB sideband-separating mixers. While the new E330 band mixers still works with adjustable magnetic field, the new E230 mixer design incorporates a permanent magnet for suppression of the Josephson current. A heating element, attached to the mixer body, can be activated in case of a quantum flux trapping. Measured performance of the new EMIR bands is good and close to that obtained in the lab.

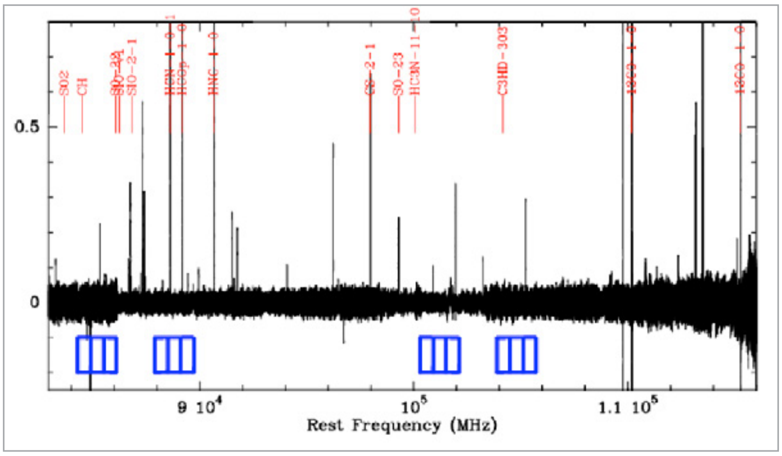
The time the EMIR receiver was down was also used for replacing the cryogenics and installation of a modified version of the IF selection unit. The new IF switch box allows connection of up to 4 wideband (4-12 GHz) receiver signals to the existing 8 coaxial cables, giving a total instantaneous bandwidth of 32 GHz. IRAM is currently investigating options to transport the full 64GHz provided in principle by EMIR, to the backends. So far only a subset of IF combinations are offered; a compromise has been taken in order to balance flexibility and complexity of the switching matrix.

The external EMIR optics used for polarimetry, initially only designed for the 3mm and 1.3mm bands, was upgraded so now it can also be used on the 2mm and 0.8mm bands. The manual selection mechanism will be later changed to a remote controllable system.

In June 2011, IRAM installed a new 32 GHz IF system, including 24 fast Fourier Transform Spectrometers (FTS) working at 200kHz or 50kHz resolution.
The new FTS units can also be connected to the 1mm 3x3 dual-polarization camera HERA which remains the instrument of choice for large mapping observations of individual lines like e.g. the ^{12}CO 2-1 line.

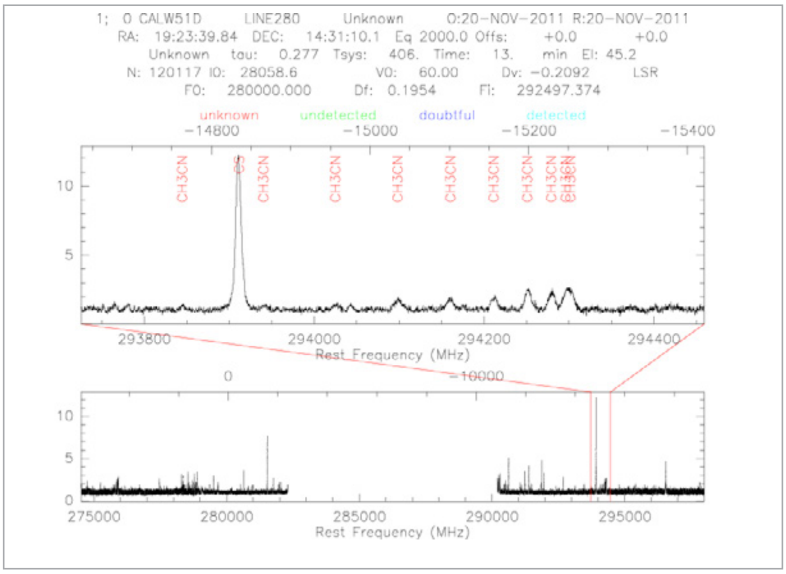
The FTS backends cover 32 GHz bandwidth at a resolution of 200 kHz. This produces 160,000 spectral channels. With a typical data rate of 1 spectrum per second (e.g. for position switched observations), this results in 2.3 GB of data per hour. Sampling rates of up to 100msec phase time have been successfully commissioned. Such high data rates have been used for frequency-switched on-the-fly mapping observations of bright Galactic sources. A remaining area of investigation concerns occasional platforming between the 3 FTS sections in the individual IF subbands. However, the bandwidth of individual FTS units at coarse resolution, in particular the bandwidth of the center unit, are 1.8 GHz which corresponds to more than 1500 km/s for frequencies of 345GHz or less. For other situations a CLASS script has been developed to fit baselines to the individual units.

A set of newly developed continuum Broad Band Detectors (BBC) for EMIR has been commissioned. The rack containing the 16 BBC modules was installed in the EMIR frame and connected directly to the IF outputs of EMIR. Each module has a home-made detector module that covers the band 4 to 12 GHz and a temperature control circuit. The data readout is done by a dedicated microprocessor board.



Frequency survey of the Galactic photon dominated region NGC7023. It covers 86 to 116 GHz at 50kHz resolution taken during 6 hours of observing commissioning time in July 2011 (Gonzalez, Kramer, Pilleri et al.). The resulting spectrum consists of 740.149 channels. The contribution of the (varying) atmosphere to the noise can clearly be seen, especially at the high frequency end of the spectrum near the atmospheric oxygen line at 118 GHz. The blue boxes below the baseline show one of the frequency setups of the 50kHz FTS units. The four boxes mark the lower outer, lower inner, upper inner, and upper outer bands of E090. Each of the bands has a total bandwidth of 1.82GHz covered by 3 FTS units. The full spectrum was created by changing the rest frequency in steps of 1.8GHz. NGC7023 is a prototypical PDR illuminated by a B2V star. The 30m data complement a frequency survey carried out at submillimeter and far-infrared wavelengths with HIFI/Herschel in the framework of the WADI guaranteed-time key program (Joblin et al. 2010) .

Spectrum of the Galactic massive star forming region W51 taken simultaneously with both sidebands of E3 and using a new command of the CLASS/GILDAS software, go browse, to zoom in a flexible way to selected regions of spectra.



CONTINUUM CAMERAS AT THE 30M TELESCOPE

After more than 10 years of successful operation, MAMBO2, the 1mm 117pixel camera, was phased out in spring 2011.

While preparing for a new large-field facility camera at the 30m, IRAM continued testing two prototype cameras, GISMO and NIKA. The GISMO camera has matured to a state where it can be offered to the general community while being further improved. The NIKA camera with its very new detector technology has rapidly improved, but is yet at a stage where further development is needed to reach the required level of sensitivities and maturity.

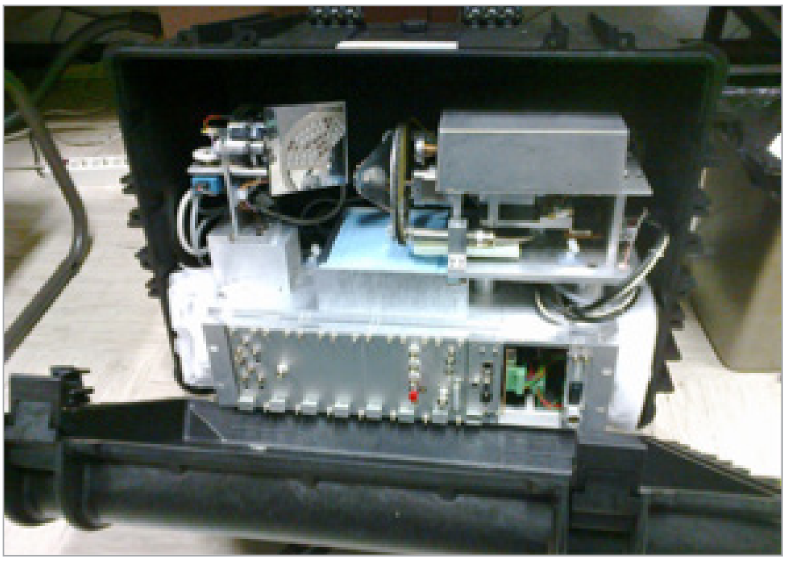
In April 2011, the 2mm prototype camera, GISMO, the Goddard IRAM Superconducting 2-Millimeter Observer, featuring 8×16 multiplexed Transition Edge Sensor (TES) bolometers, was tested at the 30m telescope during a 4th run. IRAM issued calls for proposals for the winter semester 2011/12 and also for the summer semester 2012. About 200 hours of project hours have already been scheduled for pooled observations during two weeks in April 2012.

For the 4th test run, the data processing pipeline had been largely automatized making use of the crush software package which will be used also in the future to reduce all GISMO data. Based on flux calibrations and the level of noise in the scans, the measurements of the Noise Equivalent Flux Densities (NEFD) showed a median value over the entire run of 16 mJy$\times$s$^{1/2}$. Several improvements have already been implemented in the meanwhile to get closer to this limit for the science run in April 2012. The main science objective of the April 2011 run was to obtain a 2mm Deep Field to study the potential of GISMO for detection of high-redshift galaxies. With an rms of about 130 µJy/beam in the inner region of the Deep Field, the data promise new results on galaxy counts at high redshifts.

In a 3rd test run, the New IRAM KIDs Array camera, NIKA, using kinetic inductance detectors (KIDs) was tested at the 30m in October 2011. It features two 132 pixel arrays, at 2 and 1mm, respectively. For the first time, a closed-cycle pulse-tube dewar was successfully used. A new shielding proved to be very useful to suppress parasitic noise. We have started to develop a dedicated data pipeline. Data reduction will be done with the mopsic software package. A number of issues were identified in October. A new bandpass filter for the 1mm channel has already been prepared. Cross-talk between pixels is being investigated.

IRAM started in 2011 to prepare new positions and optics for the NIKA and GISMO prototype cameras inside the receiver cabin, allowing to keep the dewars at their place over the entire year, before the arrival of the new, large-field facility instrument. An electronic levelling control of the optical table for the bolometers has been designed and built. The system will help maintaining the floating bolometer support at a precise position independently of its actual weight.

A new completely redesigned taumeter has been developed and installed at the 30m end of 2011. It works at 225GHz and does skydips to measure the atmospheric opacity about every 4 minutes, aiding astronomers to judge the atmospheric conditions for astronomical observations with the 30m between 80 and 350 GHz. The data acquisition and system control is performed via an independent microprocessor which relays the data and system parameters via the Ethernet to a Linux based laptop for data analysis. Once analyzed the result is displayed locally and remotely on the IRAM weather monitoring web page. The temperature controlled hot/cold loads within the calibration system insure reliable data, a detailed comparison with opacities of astronomical data is on the way. At the moment, the taumeter protrudes from one of the office windows of the observatory with access to all of the hardware from the inside of the building, thus offering easy maintenance throughout the year. Although installed at a fixed position, the tau meter was designed as a portable unit having overall dimensions less than (58x44x33) cm.



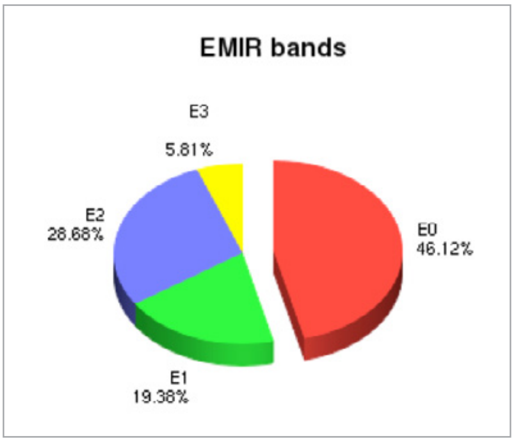
New 225GHz taumeter for the 30m telescope

OBSERVING STATISTICS

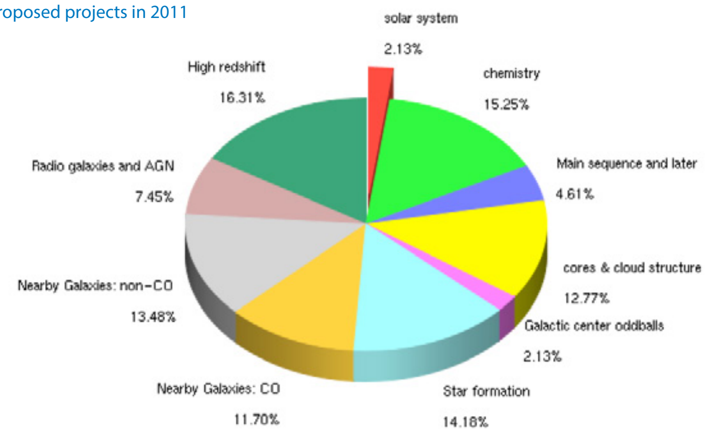
During the year 2011, a total of 174 projects were scheduled at the 30m telescope. This number includes 4 Large Programs, 9 Director's time projects, and 8 VLBI projects. A fraction of 23% of these projects was scheduled in observing pools. This is less than in 2010 when almost 40% had been scheduled in pools, due to the discontinuation of MAMBO2 after April 2012.

During the scheduling year, 155 astronomers visited the telescope, 44 of which came to support the observing pools. The fraction of scheduled time observed remotely has increased to almost 20%. From the proposals eligible for Radionet support, 19 were scheduled at the telescope, and 7 European astronomers were granted travel support.

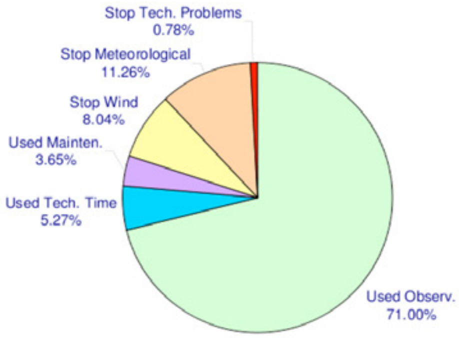
During more than 80% of the scheduled time, EMIR was used, and during about half of this time, the 3mm band E090. Figure 3 shows the use of the different EMIR bands during the entire year. The 1mm multi-beam array receiver HERA was used 7% of the time, and the 1mm bolometer camera, MAMBO2, during about 10% of the time. About half



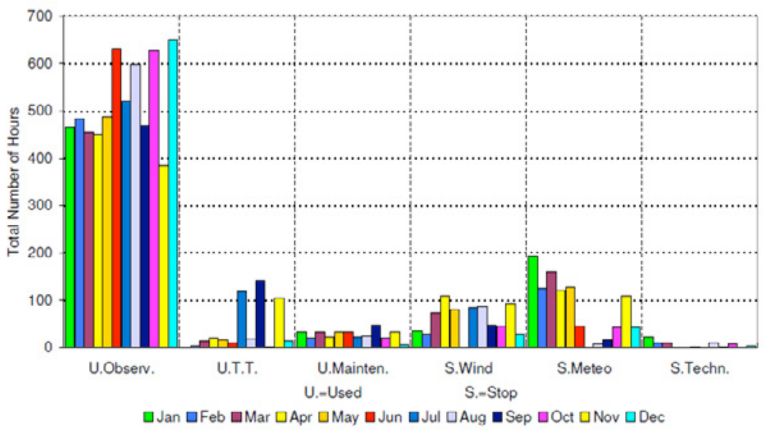
Usage of EMIR bands in 2011



Research categories of proposed projects in 2011



Time distribution at the IRAM 30m telescope in 2011



Monthly time distribution at the IRAM 30m telescope (U.Observ.: Observations, U.T.T.: technical tests, U.Mainten.: Maintenance, S.Wind: Stopped because of high wind velocities, S:Meteo: Stopped because of other meteorological conditions, S:Techn.: Stopped because of technical problems).

of the scheduled projects were devoted to Galactic and extragalactic topics, respectively.

Two global 3mm sessions were successfully carried out. A short 1mm test between the 30m and APEX failed. A new Digital Backend (DBBC) was installed together with a faster data recorder. This gives the possibility to record at a speed of up to 2 Gbit/s.

About 70% of the total time was used for observations while 20% of the time was lost due to adverse meteorological conditions. The remaining 10% of the time was essentially used for technical work, maintenance, tests, and upgrades. Similar to 2010, only 0.8% of the time were lost due to technical problems. As always, IRAM counts here failures of more than 2 hours which are directly noticed by the staff. Each important failure is monitored, analyzed and discussed to further improve the system.

TELESCOPE OPERATION AND SAFETY

The dedicated staff for telescope operation at the 30m telescope is concerned with daily operation and the related technical questions such as telescope characterization, preventive maintenance and repair as well as general trouble shooting.

Other important activities in the telescope area during 2011 were:

- the replacement of two more gearboxes. In September 2012, IRAM plans to exchange the last two of the in-total six gearboxes. The new gearboxes have been manufactured and installed by the company Desch. Before and after the exchange of the gearboxes, IRAM measured their vibration to characterize the operation of the gearboxes, installed manual cranes on the roof of the motors room to permit the exchange of the gearboxes, reinforced the roof of the motors room to support the gearboxes load, and characterized the stiffness, transfer function, hysteresis, rolling friction and operation of the brakes.
- The quadrupod temperature control system has been improved by installing a new glycol pump with electronic flow control. The regulation of temperature of the quadrupod dropped to only 0.4°C peak-to-peak variations, improving on the control of the focus.
- Workers of Vertex and MT Mechatronics visited the telescope and started to investigate a possible re-painting of the primary dish, as some of the panels have started to loose their white top layer of paint revealing the underlying layer of dark primer.
- Several measures were taken to improve the maser system EFOS10 for VLBI.
- Parts of the antenna backstructure have been painted and age-worn rivets at the quadrupod have been replaced.
- Several measures have been taken to further improve safety at IRAM/Spain, and in particular

at the 30m observatory. A new GPS system with improved sensitivity has been installed in the Ratrak. A thermoelectric revision of the electrical installation was done. Sixteen IRAM workers participated in a training course on cardio pulmonary reanimation including the use of a semi automatic defibrillator. A system "man in danger" is now regularly used by operators when they work on their own in the telescope. Regular emergency simulations have been organized with the Granada emergency service 061. A video link to the emergency hospital is currently being prepared, and a test evacuation by helicopter of the Guardia Civil is planned for Summer 2012. The 30m Emergency Plan has been updated.

COMPUTERS

Data handling In 2011, the FTS backend was upgraded from 8 to 24 units. In order to handle the increased amount of backend data, we strongly increased disk space, connected all systems to a 1Gbit/s network switch, bought a new tapeloader system able to handle up to 48 tapes of 1.6TB each (LTO-5), and moved the computer system with the project archive from Granada to the observatory. The online data processing (ODP) is now done via pipelines per backend. All backends are processed in parallel.

Radiolinks The network links between the observatory and the IRAM Granada office and between the Granada office and the University of Granada have been improved. We now have two radiolinks on each link. The network switches allow automatic fallback to one link in case of failure and can use both links in parallel. Between Granada and the observatory we now offer 100 Mbit/sec.

TAPAS TAPAS is a data base of header information from all observations and has been built in collaboration with the Instituto Astrofisica de Andalucia (IAA). It has been continuously fed with new data since October 2009. Observers can access TAPAS via the 30m homepage. We regularly sent a subset of all header information to the CDS (Centre de Données astronomiques de Strasbourg).

CONTROL SYSTEM (NCS)

IRAM added support for the expanded bandwidth of EMIR and backends in paKo and the related components of the NCS and data handling software in three major steps. First came the Broad Band continuum Backend BBC, and the previous continuum backend was renamed NBC (Narrow Band Backend). During the summer, the IF system was upgraded and 24 FTS backends were installed to cover the full 32GHz of bandwidth available from EMIR, and of course all channels of HERA. PaKo and NCS were upgraded to support these changes, and both resolutions of the FTS. Starting in late summer, IRAM prepared for the upgrade of EMIR bands E230 and E330 and a new IF switch box to select the EMIR sub-bands on 8 IF cables. This of course also meant another major iteration of the commands for the backends, in particular BBC and FTS. The revised paKo commands for receiver and backend now include some additional flexibility that is not yet supported by the data processing, e.g., to select FTS data for parts of the EMIR sub-bands.

Support for the MAMBO bolometers was decommissioned; however, for technical purposes it is still possible to set the secondary rotation. For the GISMO Lissajous curves, strict elevation conditions are enforced to protect the antenna mount drive hardware against excessive velocities and accelerations. Special features are now more systematically protected against unintended use by requiring special privilege or user level commands. The /disconnect and /connect options for receiver and backends were declared obsolete. The default value of the time per phase, i.e., per data sample, in total power mode was changed to 1 sec.

IRAM 30M SUMMERSCHOOL

For the 6th IRAM 30m summerschool which took place in September, 23-30, 2011, in the Sierra Nevada, IRAM had received more than 110 applications, more than ever, showing the strong increase of interest in single-dish radioastronomy in the wake of Herschel and ALMA. For logistical reasons, IRAM had to select only 40 participants who came from 33 institutes in 19 countries on 5 continents.

As is by now tradition, lectures were combined with hands-on observations at the 30m telescope. On the first day of the school, the participants split-up into groups covering six contemporary topics, to prepare a science case, conduct the observations, digest the data, and present first results at the last day of the school.

For the lectures, IRAM invited six seasoned astronomers with rich experience at the 30m on key topics representing the variety of science cases that are at present being studied with the 30m telescope, i.e. on star formation in the Milky Way and in the early universe, shocked and photon dominated regions. In addition, the institute included lectures on instrumentation and software: on heterodyne receivers, continuum detectors, spectrometer backends, data processing software. All lectures are available on the summerschool homepage.

Participants of the IRAM 30m summerschool 2011

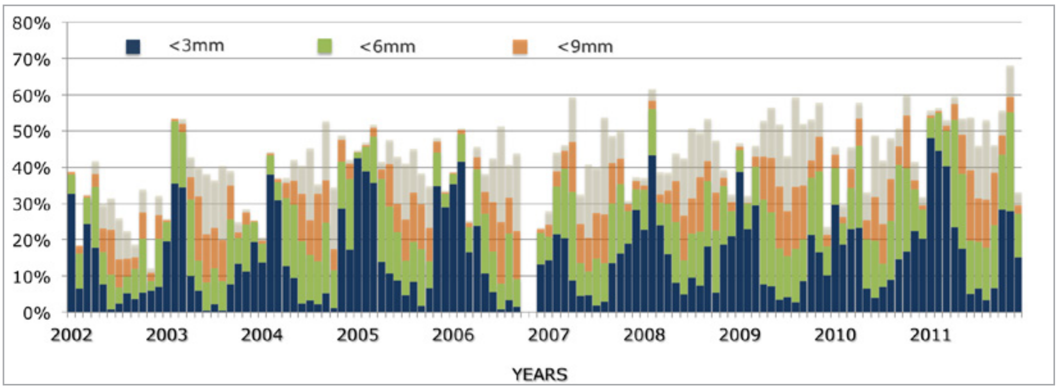
Plateau de Bure interferometer

The operation of Plateau de Bure Interferometer in 2011 provided images of unprecedented quality and resolution suitable for the investigation of a range of cutting edge issues, and is characterised by a large number of outstanding scientific results.

The interferometer performed according to expectations with almost no downtime due to hardware upgrades, maintenance operations and work in preparation of NOEMA. The receivers and the antennas all worked well throughout the year. Science observations were performed in periods of excellent phase stability and atmospheric transparency in winter and autumn, but faced somewhat less favourable conditions in spring and summer.

As in previous years, the percentage of telescope contiguous correlation time scheduled for observing programs was on average 50% of the total time. Additional 20% have to be accounted for receiver tuning, related checks and other unavoidable observational overheads, array configuration changes, interferometer upgrades, surface adjustments and antenna maintenance, and on completing the commissioning and science verification of band 4; the remaining 30% were lost because of precipitation, wind and inadequate atmospheric phase stability.

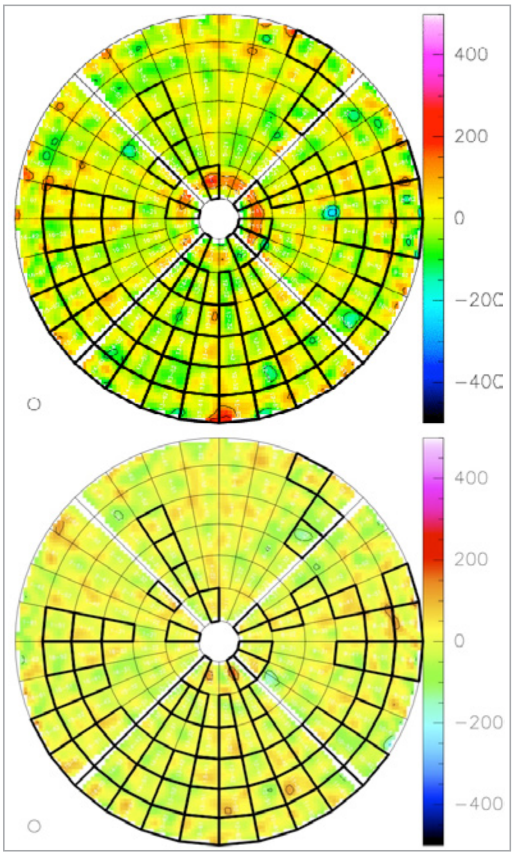
The Program Committee met twice during the year, around four weeks after the deadlines for submission of proposals and reviewed 194 applications. More than 200 different projects, including 3 Large Programs and 18 proposals for Director's Discretionary time, corresponding to 143 different observing programs, were scheduled at the Observatory in 2011. As in previous years, the weight on extragalactic research remains considerable and is about twice as strong as research on young stellar objects. Also, a fairly large amount of observing time was invested in D-configuration between spring and fall in the detection of line-emission from molecular (e.g. carbon-monoxide, water) and atomic transitions (e.g. carbon, nitrogen) in galaxies at high redshift. Annex I details all the proposals to which time was granted in the course of the year, and the list of projects testifies to the high scientific return of the



Plateau de Bure observing time and atmospheric water vapor statistics over the last ten years. The overall correlation time accounts for 55% of the total time in the year 2011. Band 3 (200 – 274 GHz) and band 4 (275 – 373 GHz) programs and observations in the most extended (AB) configurations are for the most part carried out in the winter months. The gradual increase in the observing efficiency over the years results from a combination of weather statistics, technical improvements and reduced calibration overheads.

Plateau de Bure Interferometer. The second week in May and October was devoted to coordinated 3mm VLBI continuum observations with several participating radio observatories in Europe and the United States.

ANTENNA SURFACE IMPROVEMENTS



Aperture phase pattern of antenna 1 before (up) and right after (down) the installation of the fourth point to compensate the gravity sag of the inner ring panels. After a series of holographic measurements and surface adjustments, the surface of antenna 1 was found to be flat with an RMS of 36µm. Contours are given in steps of 100µm.

In the frame of the antenna surface improvement program, a significant effort was made in the antenna maintenance period 2011 to compensate for the central gravity sag of ring 1 panels. Efforts made in 2009 on antenna 4 to equip the ring 1 panels with a fourth point to support the panels center proved to be instrumental to ensure the mechanical stability of ring 1 panels, contain the antenna efficiency losses and achieve an overall surface precision better than 50um (RMS). Building on the experienced gain with antenna 4, it was decided in 2010 to equip the remaining five antennas with the same support points. The points were installed during the maintenance period, and the surface assessed by a series of holographic measurements alternating with a series of positional adjustments. Panel work started on antenna 5 in the last week of June and completed on antenna 3 on September 26, 2011. The surface quality of all of the antennas was verified by means of holographic measurements at the end of the maintenance period. Surface panels were readjusted when deemed necessary. The final overall surface precision achieved by holography was better than 40µm (not weighted by illumination) for antennas 1, 3 and 6, and better than 45µm for antennas 2, 4 and 5.

ANTENNA SUN AVOIDANCE

Following up on the antenna surface refurbishment plan 2007-2010, Sun illumination measurements had been started in 2008 to investigate the possibility of relaxing the initial Sun avoidance constraints (45 deg). The results of these investigations led to the design of a new Sun sensor with the aim of performing observations down to a Sun distance of 25 deg. A first step was made in 2009 with the old sensors by reducing the Sun avoidance circle to 35 deg, and a second was made during the antenna maintenance period 2011 to equip every antenna with the new Sun sensor. By relaxing the Sun avoidance constraints from 45 deg to 25 deg, the region of the sky inaccessible to observations on any given date will become less than 5%, and will make many more objects of the sky accessible to observations in the extended configurations of the array. Due to the heavy schedule of activities at the Observatory during the summer maintenance period, the decision was made to limit work to the installation of the new Sun sensors and to defer the software control to spring 2012.

ANTENNA DEW POINT SENSORS

The Observatory's energy savings program is aiming at identifying and implementing cost-effective measures to reduce energy consumption. It is in the frame of this program that it was proposed to assess the efficacy of dew point sensors to monitor the surface temperature of the antennas primary mirror and to activate the surface deicing system only when required. As a first step, two antennas

(2,3) were equipped with dew point sensors in 2011. The efficacy of the dew point systems was tested extensively over a period of several months, and found to perform well. A few minor issues of improvement have been identified and are already in the process of being implemented.

CDS AND LARGE PROGRAM ARCHIVES

As in previous years, in a continuing and successful effort with the Centre de Données astronomiques de Strasbourg (CDS), data headers of observations carried out with the Plateau de Bure Interferometer are conjointly archived at the CDS, and are available for viewing via the CDS search tools. In 2011, the archive contained coordinates, on-source integration time, frequencies, observing modes, array configurations, project identification codes, etc. for observations carried out in the period from January 1990 to May 2011. The archive is updated at the CDS every 6 months (May and October) and with a delay of 12 months from the end of a scheduling semester in which a project is observed in order to keep some pieces of information confidential until that time.

The IRAM Large Program Archive (ILPA) went online in December. ILPA is the collection point for research carried out at the IRAM observatories in the framework of a Large Program. The goal of ILPA is to provide images, calibrated data cubes and visibility data from the 30-m telescope and the Plateau de Bure interferometer, and make these science products available to the astronomical community at the end of the regular data proprietary period. ILPA is the result of a joint effort between IRAM, the principal investigators of the Large Programs and their collaborators. The HERA CO-Line Extragalactic Survey (HERACLES) is the first Large Program to have entered the public domain. For specific questions concerning the Large Programs and access problems to the data repositories, users are invited to contact the IRAM Scientific Secretary.

USER SUPPORT

The Plateau de Bure Science Operations Group (SOG) is staffed with astronomers that regularly act as astronomers on duty to optimise the scientific return of the instrument, directly on the site or remotely from Grenoble, provide technical support and expertise on the Plateau de Bure interferometer to investigators and visiting astronomers for questions related to the calibration, pipeline-processing and archiving of Plateau de Bure data, interact with the scientific software development group for developments related to the long-term future of the interferometer, perform the technical reviewing of the proposals, and collaborate with technical groups to ensure that operational requirements are being met. Seven astronomers were appointed to the group at the beginning of 2011, six astronomers at the end of 2010. The group also received the support of Arturo Mignano, a visiting astronomer from INAF/Bologna on a three months stay, and from Simona Gallerani from INAF/Roma on a six months stay.

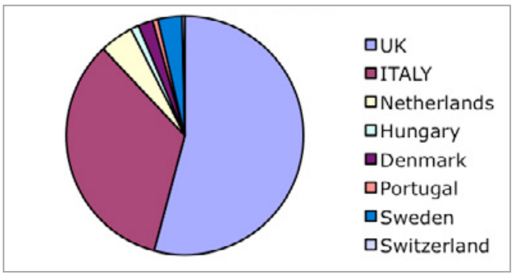
A major and continuing effort was made in the context of extending and improving the PdBI data calibration pipeline. In 2011, efforts were directed to improve the pipeline's robustness, automatically calibrate Band 4 observations, refine the flux calibration and data quality assessment procedure, and produce detailed reports on detection and mapping projects. In parallel, a major effort has been and still is being invested to improve the accuracy of the flux calibration scheme in use at the observatory.

In 2011 assistance was given to 56 investigators (almost twice the number in 2010) from Europe and overseas visiting IRAM Grenoble for a total of 156 days to reduce data from the Plateau de Bure Interferometer. Advice and support was also provided to a number of experienced astronomers from Caltech/Pasadena, CSPF/Copenhagen, IAA/Granada, MPIA/Heidelberg, CEA/Saclay, and NAO/Tokyo for a total of 43 days to reduce and analyze Plateau de Bure Interferometer data remotely from their home institutes.

RADIONET USERS

Since January 2004, travel funds have been made available to RadioNet eligible astronomers from non-IRAM partner countries for expenses incurred during their stay at IRAM for reducing data from the Plateau de Bure Interferometer. The FP7 program today manages these funds, which were initially

RadioNet observing time was allocated to eligible principal investigators from United Kingdom (percentage of total time is 54%), Italy (34%), the Nether-lands (5%), Sweden (3%), Denmark (2%), Hungary (1%), Portugal (1%), and Switzerland (<1%) with a balanced distribution between PhD students and post-doctoral researchers (47%) and senior scientists (53%).



made available by the European Commission in the frame of the FP6 program. For the year 2011, the Program Committee received 34 eligible proposals (25% more than in 2010) and recommended 19 proposals (7 A-rated, 12 B-rated) for observations with the Plateau de Bure Interferometer. Taking into account proposals accepted in 2010 but continued in 2011, time was allocated to 16 eligible proposals corresponding to a total of 337 hours of observing time. Since the beginning of RadioNet, access time was allocated to 78 eligible proposals (12 in 2004, 11 in 2005, 11 in 2006, 13 in 2007, 14 in 2008, 6 in 2009, and 14 in 2010) for observations with the Plateau de Bure Interferometer, corresponding to a total of ~2200 hours (272 in 2004, 239 in 2005, 272 in 2006, 326 hours in 2007, 334 in 2008, 140 in 2009 and 266 in 2010) of observing time. User responses to questionnaires of the EU show that IRAM continues to maintain an excellent reputation concerning the assistance and service given by scientists and support staff to visiting astronomers.

VLBI NEWS

Both IRAM observatories participated in the May and October Global millimeter VLBI sessions.

During the May session, the Plateau de Bure interferometer could observe 88% of the requested schedule; the missing scans were mostly due to program sources that were within the Sun avoidance of the Plateau de Bure antennas. The IRAM 30-m observed 81% of the time. On Pico Veleta, the EFOS-10 hydrogen storage was refilled on May 16th (i.e. shortly after the session) and the maser successfully restarted with remote assistance by the Swiss T4Science company.

In October, the interferometer experienced an extended bad weather period with rain and high wind; only 25% of the scheduled scans could be observed. Pico Veleta had a nearly perfect session with about 99%.

22 GHZ RADIOMETRIC PHASE-CORRECTION SYSTEM

During the first season of band 4 observations, it became evident that the new part of the LO system was interfering with the first radiometer channel. This problem was solved with the installation of appropriate shielding in the band 4 LO boxes during the summer maintenance period. On the software side, an additional WVR «dual channel» mode has been added to the CLIC offline data reduction. This tool allows converting the atmospheric phase correction from a triple channel to a dual channel system, and thus conserving some benefits of the monitors for continuum data even when the low-frequency channel is lost.

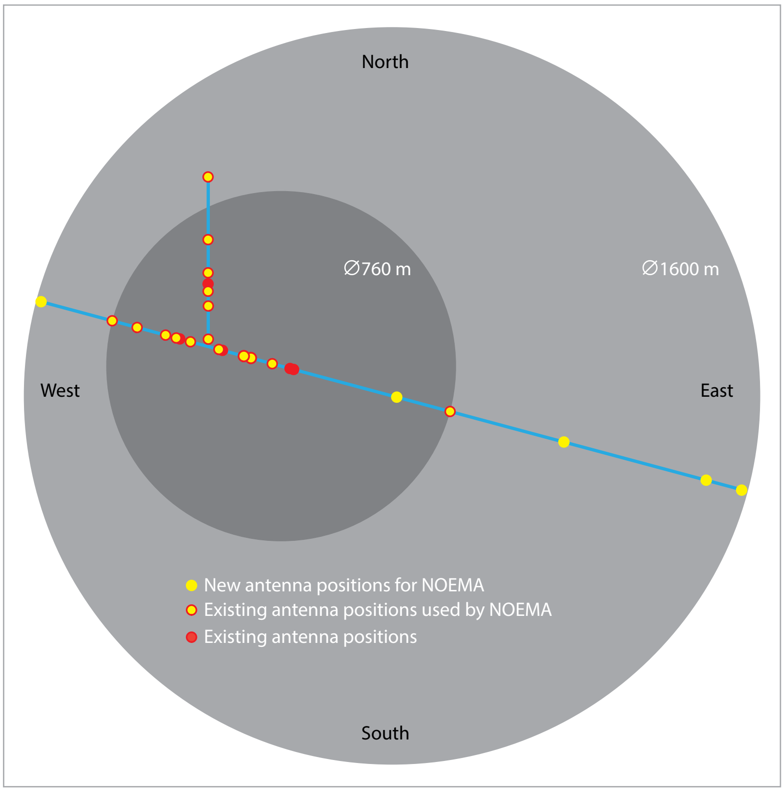
Several telecom operators requested permission in 2011 to install microwave links around the Plateau de Bure. Fortunately their frequencies could be shifted outside the critical frequency ranges so that interference towards the radiometers and the LO system could be avoided.

NOEMA

Since six years IRAM has prepared and lobbied a groundbreaking extension of its interferometer on the Plateau de Bure site in order to maintain its position as a world leader in Millimeter Astronomy in the ALMA era. The Northern Extended Millimeter Array Project, NOEMA foresees to double the collecting area (6 additional 15m antennas) and baseline length as well as to quadruple the IF bandwidth as compared to the existing PdB Interferometer. Within these specifications NOEMA will reach >50% of the ALMA continuum and line search sensitivity in the frequency range of 80-365 GHz and >35% of single line sensitivity.

NOEMA will give the IRAM partner organizations the possibility to conduct large surveys in the fields of galaxy evolution, star formation in the Milky Way and in nearby galaxies and finally for high spectral resolution chemical finger printing of interstellar matter. Due to its comparable millimeter sensitivities the project will further allow for very efficient preparation of ALMA observations at higher spatial resolution and higher frequencies. With its lean and flexible operation it will create important discovery space and at the same time assure, together with ALMA, all-sky coverage in the millimeter wavelength range.

After the strong support from an international visiting committee, the IRAM partner organizations CNRS (France), MPG (Germany) and IGN (Spain) have signed in June 2011 a Memorandum of Understanding which marks the transition from preparation phase to actual construction phase for this very ambitious project. In their memorandum the IRAM partners agreed to finance the required investment for a first phase of NOEMA. With a budget of 33 MEu this Phase I includes the construction of 4 supplementary antennas, the construction of 4 receivers for the new antennas and a complete upgrade of all existing receivers to an 8 GHz 2SB technology and finally the construction of a new backend for this bandwidth which will readily be able to cover the signals from the total of 12 antennas foreseen within the global NOEMA project. NOEMA Phase II will cover the construction of 2



x12 NOEMA project

more antennas and the extension of the baseline to 1.6 km.

The period after the signature of the MOU has seen intense project activity on all fronts.

After a kickoff meeting which set the internal organizational framework with the help of a global management plan, the NOEMA main specifications were translated into detailed engineering specifications and interfaces. The project schedule for NOEMA phase-I foresees commissioning of Antenna 7 in summer 2014 and that of Antenna 10 in early 2017. An information exchange platform, a document archive and a budget control scheme have been established. A global budget review towards end of 2011 has reconfirmed the validity of the financial scheme for NOEMA phase I.

On the technical side developments have been pursued with high pace on all subsystems.

The antennas will be built under an IRAM project lead and a philosophy of targeted improvements of the existing will be applied. A complete renewal of the existing drawings and technical documentations into CAD documents has been made to allow efficient subcontracting. Antenna development work has focused on weight reduction for the BUS nodes and the quadrupod structures on one side and a new subreflector support and a modern antenna drive technology on the other side. Wherever possible, new developments have adopted a strategy which will allow to retrofit the existing 6 antennas if necessary and sufficient funding is available. Negotiations with possible suppliers for major antenna subsystems have been started and the first major contracts have been prepared and will be signed in spring 2012.
For frontends and backends the final specifications and interfaces have been defined and prototyping of key units such as ultrafast samplers and wide band 2SB SIS technology have been very successful. The supply of the ultra-fast sampler chips in 5-bit technology, and as such unique key components, has been assured in a relatively early phase through a contract with the local supplier e2v. A scheme for the efficient refurbishment of existing receivers has been defined and work for additional fully electronic LO systems has been started.

A series of important tests is prepared and planned for summer 2012, this includes the software upgrade for sub-array operation for efficient antenna commissioning and tests of sub-sets of the new antenna drive systems.

Despite a very difficult economic context the idea of NOEMA has made its way from a mere concept to a real project. This quite outstanding path has not to the least been achieved through the support of many organizations and individual persons outside of IRAM, a support and a confidence which IRAM and its staff will honor with greatest motivation and dedication.

IRAM and its partner organizations sign the Memorandum of Understanding, June 2011.

Grenoble headquarters

FRONTEND GROUP

The main activities carried out by the Frontend Group in 2011 concerned: *a)* the maintenance of the Plateau de Bure receivers, *b)* the maintenance, upgrade and development of the Pico Veleta receivers, *c)* the continuation of the ALMA Band 7 cartridge production, *d)* the development of harmonic mixers and laboratory test equipment, and *e)* the LNAs development within the European AMSTAR+ collaboration.

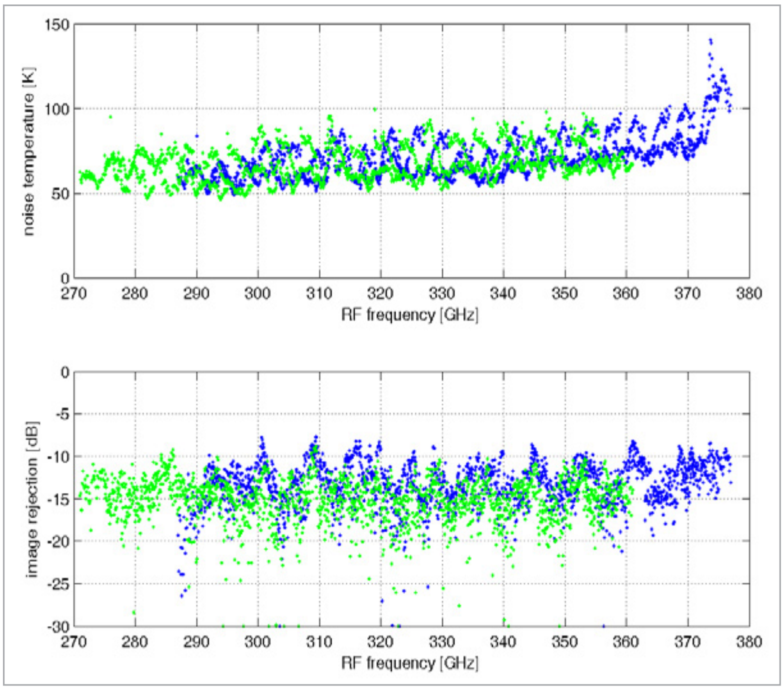
PLATEAU DE BURE INTERFEROMETER MAINTENANCE

The maintenance work concerned the Sumitomo cryogenerators and compressors: the four cold heads installed on Ants. #1, #2, #3 and #4 were replaced after five years (40000 hours) of continuous operation; also, five compressor absorber were replaced on Ants. #1, #2, #3, #4 and #6. On Ant. #5, the compressor was replaced after its failure in March 2011 and the cryogenic cold head was replaced in December 2011 due to increased temperatures of the 77 K and 15 K stages.

Two Band 4 (275-373 GHz) cryogenic modules were replaced on Ant. #1 and on Ant. #5 (on Ant. #1 the SIS mixer chip of Pol V was in open circuit since last cooling down of September 2010, while on Ant. #5 the module was swapped with one having better receiver noise performance). Following a cooling down of the Ant. #4 receiver in Oct. 2011, one of the Band 4 Pol H SIS mixer chips is in short circuit. Tests of spare Band 4 modules were performed in the laboratory to replace the defective one.

After the installation of the Band 4 electronically tuned Local Oscillators (LOs) on the PdBI antennas in 2010, it was found that the commercial 15.7-20.3 GHz YIG oscillator that drives the final 283-365 GHz LO band contaminated one of the three channels (n. 1) of the 18-26 GHz Water Vapour Radiometers (WVRs). Therefore, all six (plus spares) LO Band 4 modules were retrofitted to screen the internal YIG interference emission as to avoid perturbations of the concerned radiometers channel. Tests performed in the laboratory, followed by measurements at the PdBI site, showed that the careful electromagnetic isolation of the YIG oscillator inside the Band 4 LO module allowed to supress the radio frequency interference (RFI) below any detectable level and to re-establish the full radiometric stability of the WVRs channel as per initial specification.

MAINTENANCE, UPGRADES AND NEW DEVELOPMENTS FOR PICO VELETA



Receiver noise (above) and image sideband rejection (below) of one Band 4 sideband-separating mixer measured across the 4-12 GHz IF band for LO frequencies between 283 and 365 GHz. LSB measurements are plotted in green, USB in blue.

The maintenance was made of the EMIR Sumitomo compressor and cryogenerator as well as of the Daikin cryogenerator of the HERA multibeam receiver.

An upgrade of both EMIR Band 3 and Band 4 receivers was made in November 2011: the Band 3 backshort-tuned Single Side Band mixers with 4-8 GHz IF band were upgraded to 200-280 GHz sideband separating (2SB) mixers with 4-12 GHz IF band per sideband. The 2SB B3 mixers, which include miniature permanent magnets for the suppression of the Josephson effect, are cascaded with 4-12 GHz IF hybrid couplers and low noise amplifiers developed by CAY, and interconnected through commercial cryogenic isolators. The cryogenic optics module was modified to incorporate a new waveguide LO polarization splitter and new waveguide structures, which support the polarization splitting wire grid and interconnect the two feed-horns to the 2SB mixer units. Unlike the 2SB B3 mixers, which were developed in 2010 within the European funded AMSTAR+ project, the construction and test of new mixers for EMIR Band 4 took place mostly in 2011.

EMIR Band 4 upgrade to 4–12 GHz IF band:

The 2SB Band 4 mixers which were installed in EMIR before the November 2011 upgrade covered an RF frequency range of 275–373 GHz with an IF band of 4–8 GHz; these mixers were a modification of those originally designed for ALMA Band 7. Therefore, two new Band 4 mixers were fabricated to replace the existing ones at the Pico Veleta site allowing to double the instantaneous IF bandwidth of the receiver. The 4-12 GHz cryogenic IF section of the Band 4 receiver comprises: *a)* IF hybrid couplers from CAY, *b)* commercial cryogenic isolators and, *c)* low noise amplifiers from Caltech. The upgraded 4-12 GHz room temperature IF modules, almost entirely based on commercial components, are a copy of those developed in the past for Emir Band 1 (already based on 4-12 GHz 2SB mixers).

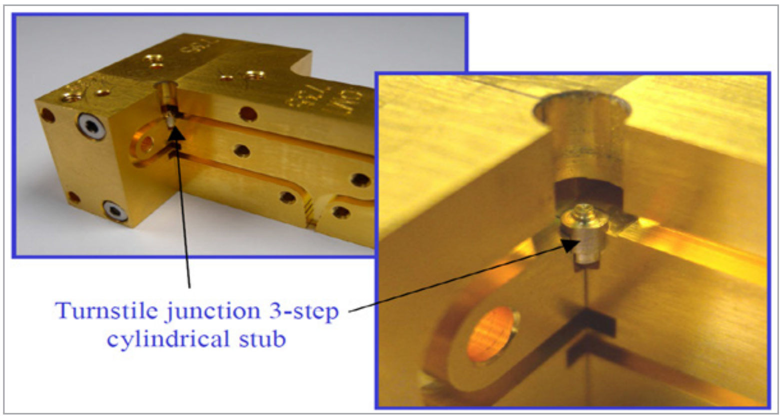
Spectrum slicers for the FFT backends

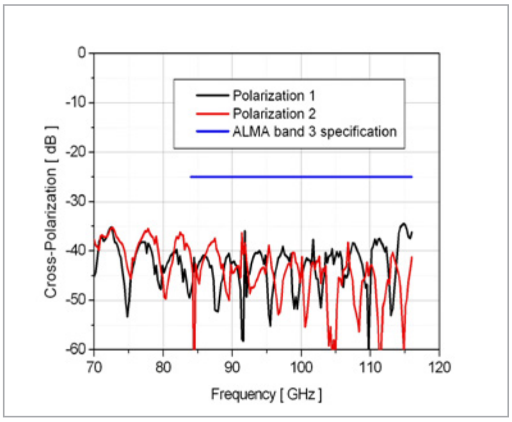
A new IF processor was developed to interconnect the IFs of either the HERA or the EMIR receivers with a set of 24 Fast Fourier Transform spectrometers from Radiometer Physics GmbH. The spectrum slicers is an analog IF processor consisting of 24 sub-units arranged in two identical racks (with a common power unit). Photo of one of the racks built in 2011 is shown in the figure. During Summer 2011, the spectrum slicers was installed on the Pico Veleta telescope and was connected between the receivers and the FFT units, where it proved to work satisfactorily.

Top left: One of the two spectrum slicer racks (with cover removed) including 12 sub-units.
Bottom left: Spectrum slicers and common power unit. Right: FFT backends installed on the 30 m telescope. Three FFT racks (each including eight FFT units) and two spectrum slicer racks are connected through coaxial cables.

3 mm band multibeam receiver

Good progress was made on the design of a 5x5 pixels dual-polarization 2SB SIS receiver for the 3 mm band. Some of the receiver components, like a wideband orthomode transducer and a feed-horn, were developed. A study of new materials with reduced mass density (weight) and improved thermal and electrical conductivity over traditionally used ones (gold plated brass or copper) is underway in collaboration with the mechanical workshop group. Different types of Aluminum are under tests, one of which will be selected for the fabrication of the cryogenic module waveguide parts.





Above: Turnstile junction OMT with one of the four parts removed to show the internal waveguide circuitry and the 3-step cylindrical stub used for improved matching of Left: Cross-polarization performance of one of the OMTs.

Orthomode Transducer: An Ortho Mode Transducer (OMT) for the 3 mm band multibeam receiver was designed, manufactured and tested at IRAM. An OMT allows to separate two orthogonal linearly polarized signals within the same frequency band and is an alternative to the polarization splitting wire grid used in all IRAM heterodyne receivers. The OMT, based on a waveguide turnstile junction, consists of four gold plated brass blocks plus a 3-step cylindrical stub. The measured performances of the OMT are within the specification of ALMA Band 3 (84-116 GHz). The device operates satisfactorily over a much wider bandwidth, 70-116 GHz. The cross-polarization level achieved with the OMT (-35 dB max) is comparable to that of a wire grid.

Wideband feed-horns: New feed-horns were designed and manufactured for operation over the extended the 3 mm band 72-116 GHz. The feeds have a profiled section (with 5-steps conical parts) to reduce the beam divergence at their outputs. The measured input reflection is lower than –20dB across 71-116 GHz.

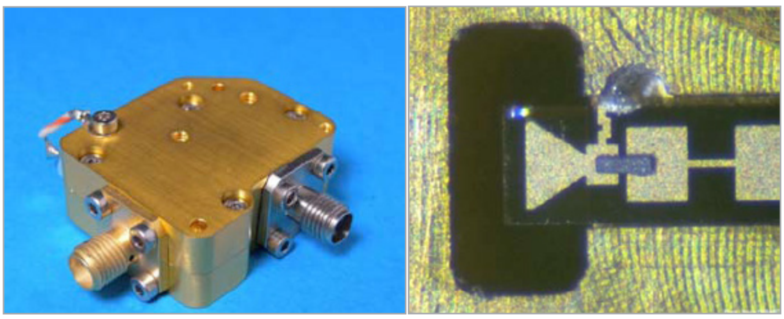
ALMA BAND 7 CARTRIDGE PRODUCTION

In 2011, 19 ALMA Band 7 production cartridges were delivered to the project. During the same period, four pre-production cartridges were returned to IRAM for refurbishment; these cartridges were upgraded, re-tested and returned to the ALMA integration centres or the ALMA Operations Support Facility (OSF) in Chile. At the end of December 2011, a total of 60 cartridges were provided to ALMA.

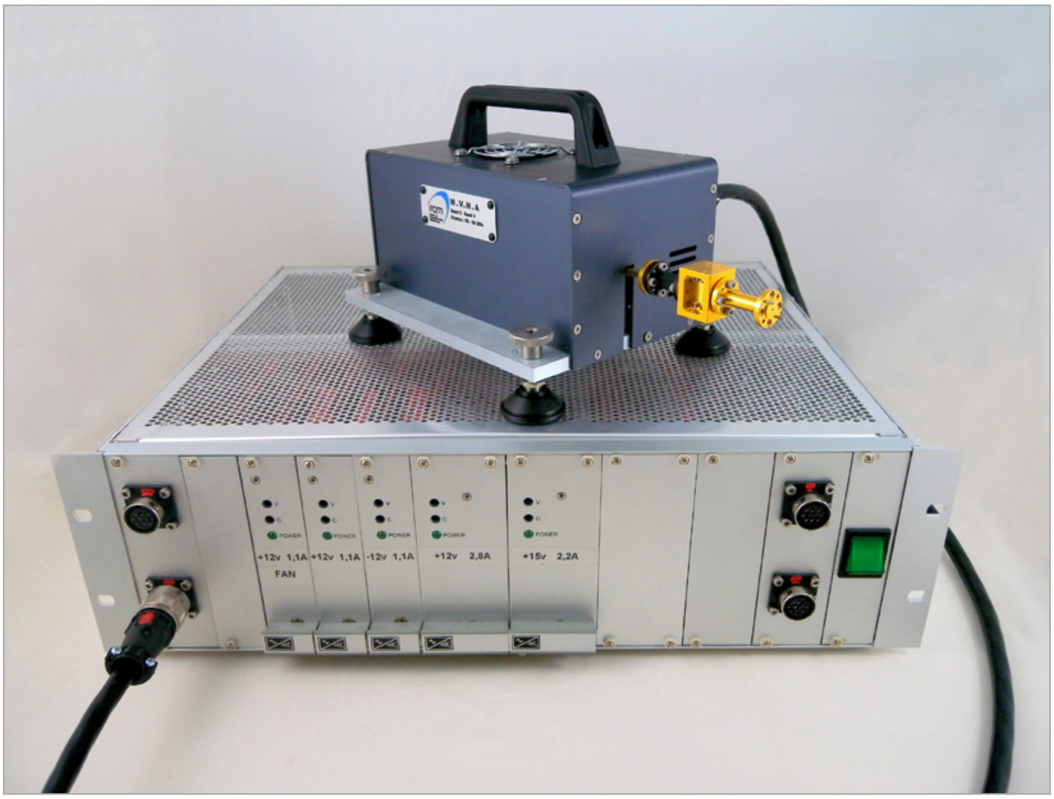
DEVELOPMENT OF HARMONIC MIXER AND LABORATORY TEST EQUIPMENT

Harmonic mixer for 200-280 GHz

An harmonic mixer was developed for the 200-280GHz frequency band. The device finds application on the Millimeter Vector Network Analyzer (MVNA) and on the antenna measurement range, in particular on the characterization of waveguide and optical components for the future NOEMA Band 3 receivers (200-276 GHz). The measured conversion gain is flat, of order -30 dB, across the entire band.



Left: Photo of assembled harmonic mixer. Right: photo of the internal details of the harmonic mixer showing the waveguide probe with diode mounted on the chip.



IRAM 200-280 GHz active multiplier chain (signal source) sitting on top of the MVNA multiple power supply. A commercial frequency tripler is attached to the 60-90 GHz source output.

MVNA design for the NOEMA bands

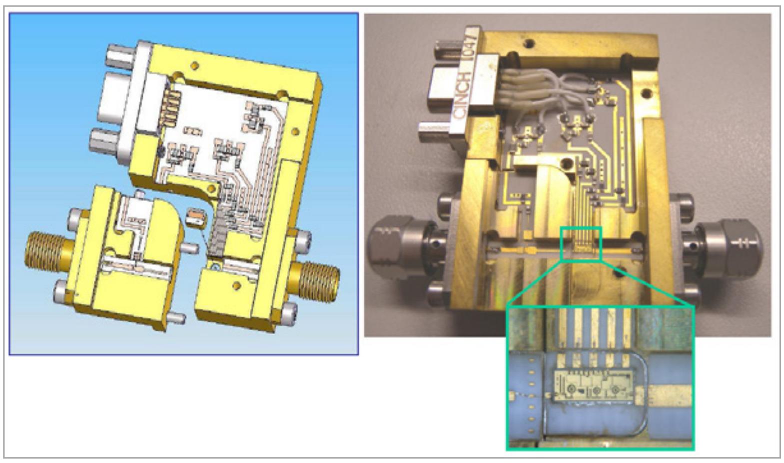
A new generation of mm-wave test set extension modules for the Agilent 43.5 GHz PNAX Vector Network Analyzer (VNA) were designed for the following bands: 70-116 GHz (Band 1), 127-179 GHz (Band 2) and 200-276 GHz (Band 3). The instruments will allow full two-port S-parameters characterization of mm-wave devices. The test set transmission-reflection modules include waveguide couplers, harmonic mixers, LO frequency doublers and low noise IF amplifiers. The various modules will cover the three first NOEMA RF bands. A single 60-90 GHz active multiplier chain (AMC) source for the MVNA was built (see figure) to cover both Band 2 and Band 3 when cascaded with either a frequency doubler or a frequency tripler. The measured average output power of the source is –3 dBm across 180-280 GHz. A multiple power supply for all test sets was also built.

WBAND HEMT AMPLIFIERS

Within the framework of the AMSTAR+ collaboration with other European Institutions, one of the IRAM Front End Group activities concerns the packaging and cryogenic characterization of MMIC low noise amplifiers based on metamorphic HEMT technology fabricated at IAF (Fraunhofer Institute, Freiburg, Germany). Different IAF MMICs for the 1-4 GHz; 4-12 GHz, 10-18 GHz and 20-25 GHz frequency bands were packaged and tested at IRAM in 2011.

Measurement setups were developed to characterize the various LNAs of the different bands at cryogenic temperatures. Noise temperatures and gain stabilities of some of the tested LNA designs are close to the best state of the art InP amplifiers.

Views of the IRAM cryogenic 4-12 GHz LNA integrating an IAF MMIC with external matching network. A modular design was used to allow the replacement of the MMIC and the input matching circuit without destroying the chip.



SIS GROUP

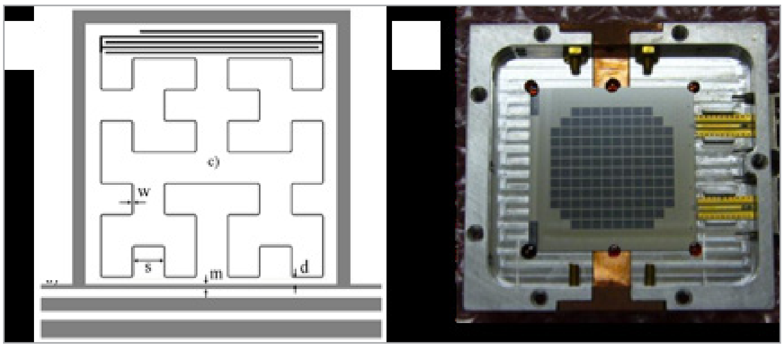
In 2011 the IRAM SIS group continued work on fabrication of new designs of SIS mixer chips for the IRAM telescopes as well as for other projects such as wide band mixers for the SMA (Submillimeter Array). 2011 focused on the frequency range of 230 GHz for IRAM and a very wideband prototype 350 GHz for the SMA with as much as 3 junctions in series.

The development of kinetic inductance detectors (KIDs) with Aluminum- and TiN-films has continued with high pace to prepare for a facility instrument at the 30m based on this technology. While aluminum films are already reproducible with good performance and electrical properties which are well understood within the framework of classical superconductor theories, TiN turns out to be more complex. Not only requires the deposition of non-stoichiometric films a very precise process control to achieve adequate reproducibility but the physics of these highly disordered films also seems to be considerably more complex as compared to elementary superconductors.

The IRAM SIS group was also active in performing electromagnetic modeling and characterization of lumped element KID devices (LEKIDs) within the framework of a PhD thesis. The close proximity of fabrication and device modeling and finally detector characterization, in collaboration with the Institute Neel, was particularly efficient to improve on the performance of the detectors. In particular a novel dual polarization LEKID structure was proposed and successfully implemented during 2011. With this structure a factor of 2 in sensitivity increase could be achieved. Next steps in device optimization will include improvements of pixel cross talk and uniformity in resonator characteristics across the detector array. A program to allow processing of larger substrates (from 2 inches to 3-4 inches) for the KID array development has been started at IRAM. This includes studies for upgrading of the vacuum deposition equipment with larger targets as well as preparation of lithography equipment for such substrate sizes.

The development of MEMS elements has been continued and this program has now yielded interesting synergy with the development of passive circuit elements such as air-bridges for CPW transmission lines, superconducting IF-hybrids, membrane based planar OMTs and other passive elements.

In 2011 the SIS group has organized with the help of the science support staff two very

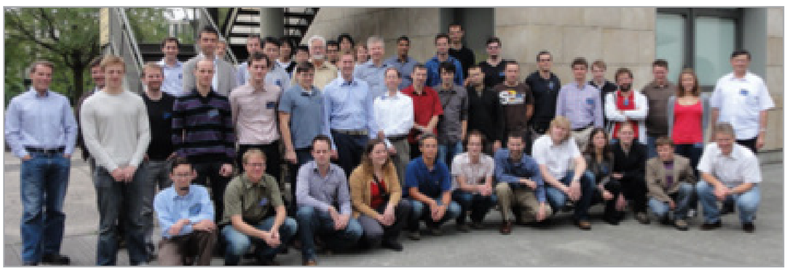


Left: Layout of a millimeterwave LEKID pixel as developed at IRAM. The design consists of a compact interdigital capacitor and an absorbing inductor in the form of a Hilbert curve. These two elements form a resonator at 1.5 GHz which can be read out with a probe tone coupled through the CPW transmission line visible at the bottom of the plot. Right: LEKID focal plane array for 2mm wavelength with 132 pixels. This type of array was successfully tested at the IRAM 30m in fall 2011 with a NEFD of 20 mJy/√ Hz.

successful meetings. On July 28th and 29th 2011 an international workshop on superconducting microresonators has been held on the Grenoble Campus. This workshop was the 4th of its kind with earlier meetings hold in US and the Netherlands. More than 50 participants from over 10 countries were present including many scientists from US and Japan. The workshop testified the high interest in this field for applications on radiation detection and quantum information experiments.

On October 2nd-4th 2011 the SIS group organized the annual meeting on cryo-electronics in Autrans/Vercors. This three day meeting which traditionally gathers the German community on superconducting electronics was exceptionally organized in Grenoble to re-enforce contact between the numerous French groups in the Grenoble area which are active in this field and the German participants.

The meeting of 2011 was attended by nearly 60 participants and naturally focused on superconducting detectors including a tutorial section for students on these topics.



Participants of the 4th international Workshop on the Physics and Applications of Superconducting Microresonators on 28th-29th of July 2011. The meeting was hold in the 'Maison des Sciences de l'Homme' on the Grenoble university campus. Bottom:Participants of the 2011 Workshop on Cryo-Electronics in Autrans/Vercors.

BACKEND GROUP

EXPERIMENTAL PLATFORM FOR THE 5TH GENERATION CORRELATOR FAST SAMPLER

A board named DiFER (Digital Front End Rover) has been built to evaluate the quality of the ultrafast sampler chip made by E2V. It analyzes the digitized data stream with an Altera Stratix4 FPGA. The gateware for acquisition and re-ordering of the samples was installed and tested. Some alignment problems were solved by original solutions, very little useful information being available elsewhere about this topic. The perfect interleaving of the 4 cores of the chip requires very fine tuning of 12 parameters. To solve this, a special method using bandpass Gaussian noise and spectral analysis has been developed by the backend group engineers, using commercial software utilities. Fine Fourier analysis revealed some imperfections (at the LSB level) that affect two cores of the chip. This problem has been verified at E2V by the chip designers, who could trace the cause in the layout .The probability that all the chips will be affected identically was estimated very high, and this was later confirmed by measurements on an existing preseries of encapsulated devices that all showed the same behaviour.

Considering that the next generation correlator design calls for a sampling frequency of 8Gsps, which can be reached without making use of the two affected cores, the E2V ADC chip has been found adequate to equip the next generation correlator. Subsequently, by the end of the year, a contract has been issued with the manufacturer to encapsulate 120 pieces, which eventually cover the full NOEMA project.

The 64-channel polyphase overlapping filterbank gateware previously developed and simulated has been compiled, loaded in the FPGA and tested at a core frequency of 128 MHz. It behaves exactly as expected, with a very large frequency margin.

LO SYSTEMS

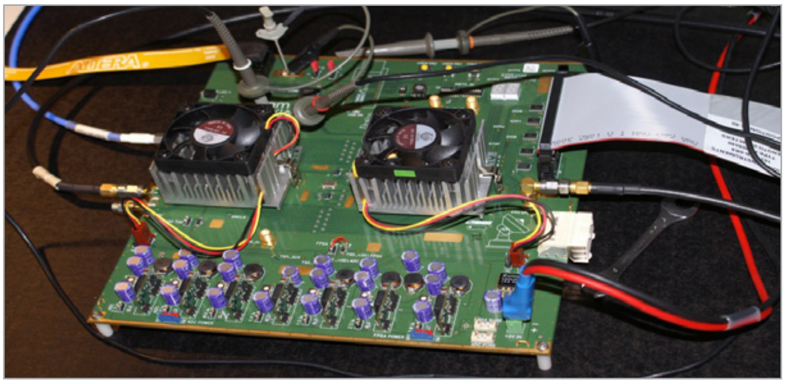
In a few antennas, the LO1 reference 16 GHz power amplifiers have failed and were replaced by the manufacturer, who acknowledges a design weakness.

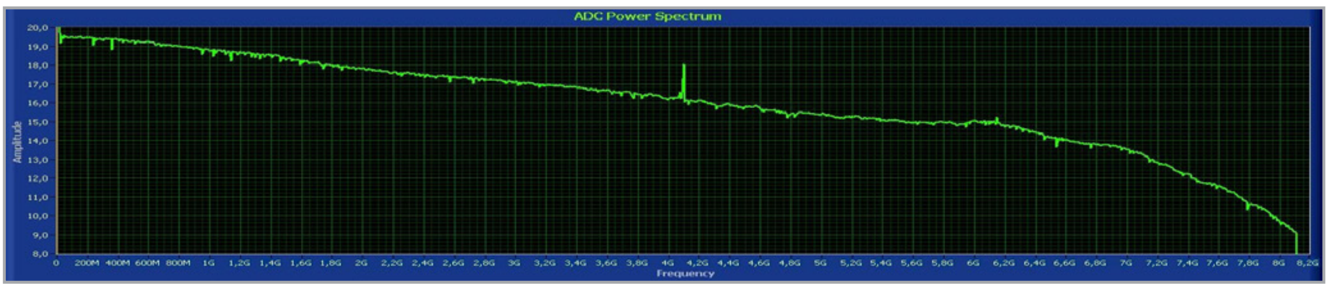
The future antennas will require additionnal LO1 phase rotators and round trip phase meters. The current equipment was built in 1995 for 6 antennas maximum, and it would be difficult to duplicate now. Although still working, it is preferred to re-design it with modern technology. A prototype board has been built to test the most recent DDS chips . Very good results have been obtained, in terms of phase noise and accuracy.

MISCELLANEOUS

- A 4 to 12 GHz optic fiber transmission has been purchased and tested for dynamic range both in Grenoble and Pico Veleta.
- A battery-backed 1pps generator has been built and installed on PdB. It simplifies time recovery in case of a major power failure.
- The backend mechanical design has switched from Autocad to SolidWorks.

The DiFER testbed
Below: Single-chunk 0 to 8 GHz IF, taken by clocking DiFER at 16 Gigasamples per second. The amplitude slope (in dB) is for a half due to external devices.





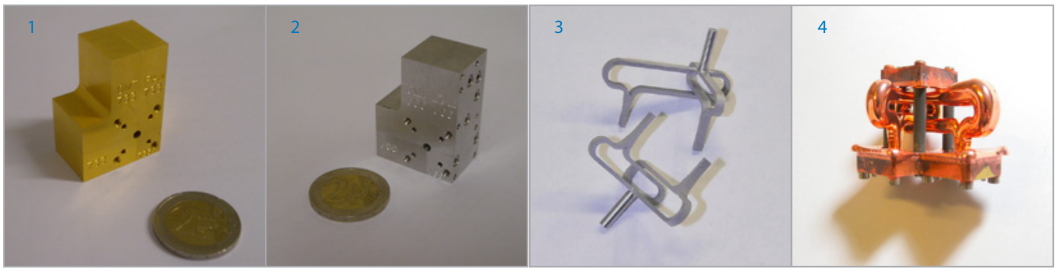
MECHANICAL GROUP

MICROWAVE DRAWING OFFICE AND MECHANICAL WORKSHOP

The microwave design office worked on numerous mechanical designs in close collaboration with the other groups; the workshop did produce a large number of microwave components, like mixers, couplers, and horns for PdB-NG2, EMIR, AMSTAR, Multibeam 3 mm and MVNA projects. The workshop still carries on producing ALMA components on time relative to the objectives.

Some new micro mechanical research topics have been dealt with, in collaboration with the Frontend group.

MASS REDUCTION OF MICROWAVE COMPONENTS



1: Brass OMT. 2: Aluminum 6060 AlMgSi OMT.
3 & 4: Electroforming OMT Component

2 new solutions have been tested:

- same machining process with new material
- new machining process with same type of material

In order to carry out reliable tests, the group made comparative tests on OMT multibeam 3 mm components. At the time being, the results are very encouraging and the design office is integrating these solutions in the multibeam 3 mm project.

WHICH PARAMETERS INFLUENCE ON LOSSES?

By machining blocks with WR10 (a=2.54 x b=1.27 mm^2) waveguides ~1.2 m long, the design office and workshop have tested different parameters:

Material

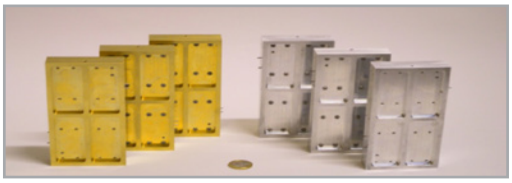
Workshop made Brass and aluminum blocks to compare measured and simulated losses across 70 and 116GHz.

Waveguide geometries

Further the location of the mechanical mating plane, losses change.

Surface roughness quality

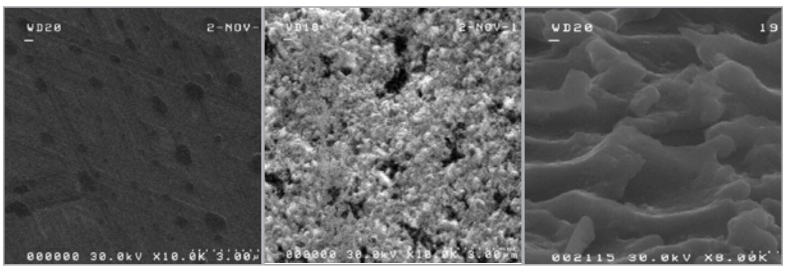
By using Diamond drill, workshop succeeded to improve surface roughness from 0,35 um Ra to 0,06 um Ra. We could analyze influence of waveguide surface roughness on losses.



Gold plated test on aluminum and brass

Different thickness and processes of gold plating has been tested. Photos made by the IRAM scanning Electron microscope.

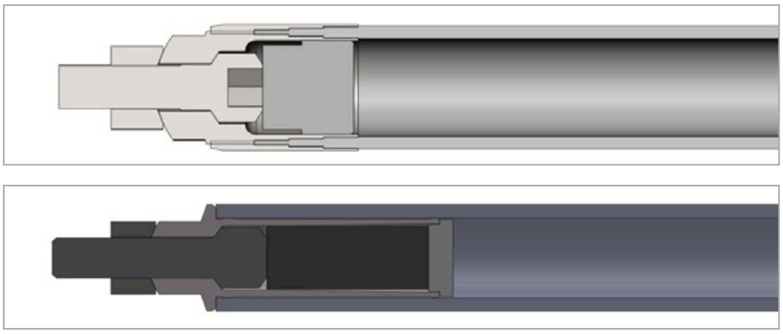
Below left: Unplanted Aluminum Aluminum electrolytic. Middle: Aluminum chemical Gold plated. Right: gold plated



NOEMA PROJECT

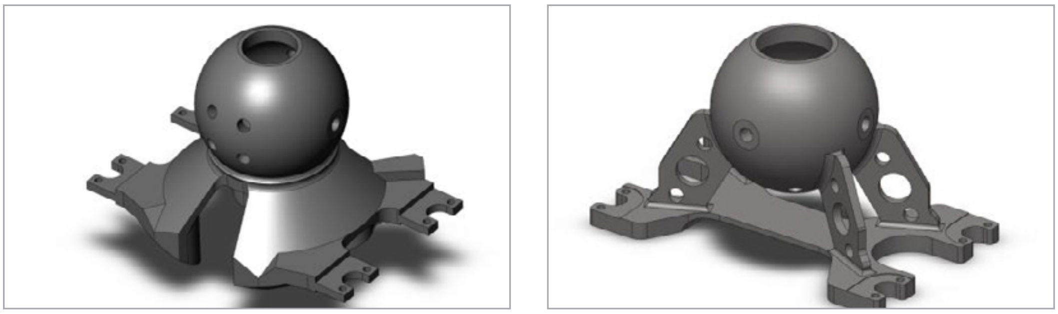
The drawing office worked on many mechanical projects to upgrade Bure antenna for NOEMA. Some of them are detailed below:

Reduction cost of panel manufacturing



Top: Current tip on CFRP strut. Bottom: New tip on same CFRP strut

In order to reduce the panel manufacture cost, we worked in close collaboration with our current supplier – Mécachrome.



Left: Current node. Right: new node with 30 % mass reduction

By integrating a lean approach on the process and a common analysis between IRAM needs and Mécachrome machining constraints, we succeeded to reach a 20 % manufacturing cost reduction, which corresponds to 150 000 Euros per antenna.

Reduction mass of the reflector

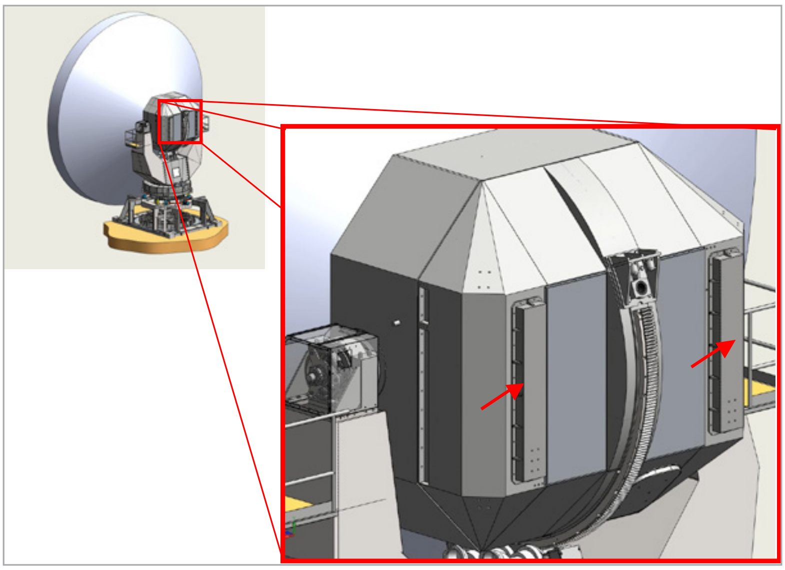
Reduction mass of the reflector, without impacted performance, is one the most important objective for future NOEMA antennas. Here after, some results of this project:

Panel actuators: Current mass of actuator is about 500 g. Design office works on new concept to reduce mass by 30 %. This concept will generate a total mass reduction of 130 kgs.

CFRP struts: By jointly working on manufacturing cost and mass reduction, design office is working on new type of tip that will generate 80 kgs mass reduction.

Nodes: The upper nodes is 6,2kgs ; as there are more than 150 nodes in the reflector, a mass reduction has an important impact.

By integrating lean approach on the manufacturing process and using the mechanical FMEA (Failure Mode and Effect Analysis) procedure, design office obtained new design of node 30 % less heavy. Presently, we are making prototypes to validate the design. This new design generates more than 300 kgs mass reduction.



TECHNICAL SUPPORT FOR ANTENNAS

As in previous years, the technical group has closely collaborated with the technical staff on the plateau de Bure for antennas.

One of the most important projects has been the balancing of the reflector. In this way, design office proposed a solution by adding a 2 tons counter weight on the backside of the receiver cabin. This solution will be installed on the first antenna during next summer maintenance phase.

COMPUTER GROUP

HEADQUARTER INFRASTRUCTURE

The Internet network connection has been upgraded from 100 Mbps to 1 Gbps in order to support the IRAM activities for the Alma Regional Center (ARC). The network link for the Plateau de Bure interferometer has been also upgraded from a 1 Mbps Transfix link to 2 Mbps SDSL link.

Following these bandwidth upgrades, the IRAM main router (a 100 Mbps CISCO router) has been replaced by a 1Gbps router. The computer group has developed an in-house solution based on a PC running Linux. It is cheaper, faster, and especially more flexible than all the existing proprietary solutions.

NOEMA PROJECT

To support the NOEMA project, the computer group has configured a wiki-based project web page and a dedicated repository for the documents. This repository is based on a Subversion server. It can be accessed either in web mode (read-only) or directly in file mode (read/write) from the Windows PCs. In this second case, the TortoiseSVN software must be installed on the Windows PCs. Therefore the computer group has automatically deployed TortoiseSVN on all the IRAM Windows computers.

ANTENNA CONTROL

Many key components of the antenna control are not manufactured anymore especially the servo-drives for the azimuth and elevation motors. Therefore the computer group has launched a study for a new antenna control system which must be suitable for the actual and new NOEMA antennas. The final choice is brushless motors with versatile digital servo drives. The new fieldbus bus will be EtherCAT (Ethernet for Control Automation Technology). This fieldbus has the vocation to replace all the other control buses actually used at the current Plateau de Bure interferometer.

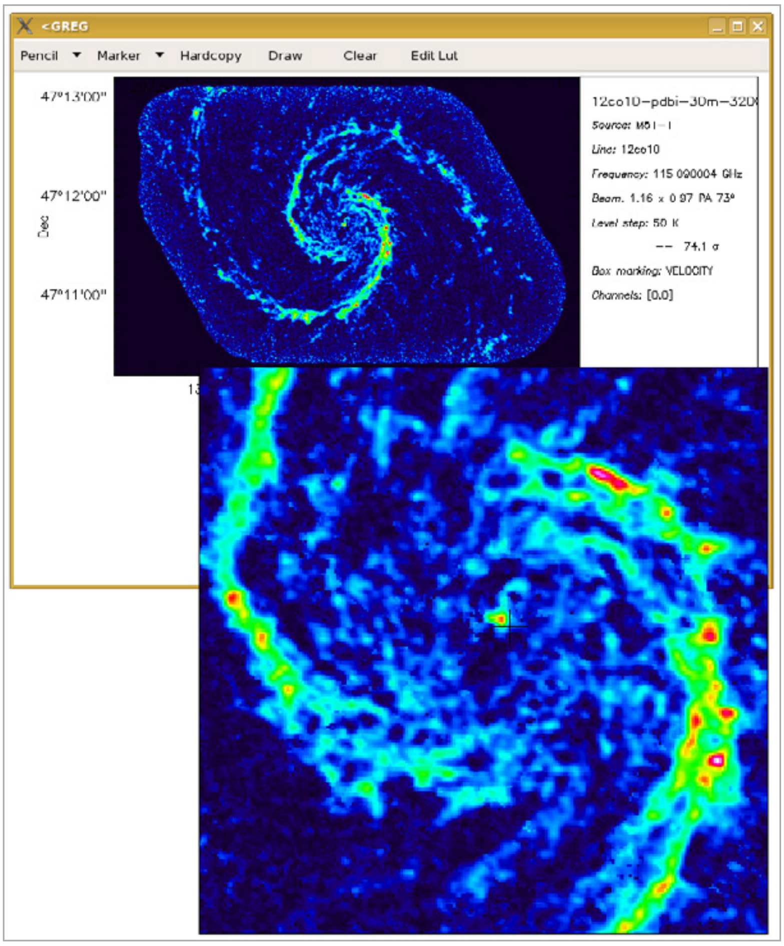
SCIENCE SOFTWARE ACTIVITIES

The main goal of the science software activities at IRAM is to support the preparation, the acquisition and the reduction of data both at the 30m and the Plateau de Bure Interferometer. This includes the delivery of 1) software to the community for proposing and setting-up observations, 2) software to the IRAM staff for use in the online acquisition system and 3) offline software to end users for final reduction of their data. However, the GILDAS suite of software is freely available to and used by other radio telescopes, like Herschel/HIFI, APEX and SOFIA/GREAT.

At the 30m, two major developments occurred in 2011. First, the use of a new Fourier Transform Spectrometer (FTS) and of the dual polarization, dual side band EMIR mixers was generalized. It is thus now possible to observe simultaneously at 3mm, 1mm and 0.8mm a bandwidth of 32 GHz with a spectral channel spacing of 195 kHz. This represents an increase of the data rate by almost one order of magnitude. CLASS, the offline data reduction software, handles this now thanks to preparatory work in 2009 and 2010. Moreover, the advent of broadband spectra at high spectral resolution triggered a series of changes in the data processing and analysis of spectra. On a more fundamental level, the handling of the spectroscopic axes in MIRA and CLASS had to be updated to remove assumptions valid only for narrow-width spectra. Some fundamental parameters like the beam efficiencies and the beam-width also evolved with the frequency, which requires adaptation of the algorithms using these parameters. Tests to use wavelets to filter baseline effects were also done. From the interface viewpoint, interactive tools were developed in CLASS to browse through spectra of hundreds of thousands of channels, label detected lines and extract/stitch spectral channels.

Secondly, NIKA (Néel IRAM Kids Array), the two-color bolometric camera, is under prototyping to prove concepts and evaluate the promising Kinetic Inductance Device technology. Some developments were required to write and read the associated IMBFits data. This allowed IRAM to participate to the analysis of the instrument stability, field-of-view, pointing and focus observations during the test campaigns at the IRAM 30m telescope. Finally, the possibility to add user-customized information in the

Exploring Greg plots and images: an interactive lens is now available at any time when center-clicking on any plotting window, and zooming/unzooming can be done with the mouse wheel. Here the lens is used to zoom in the center of the Whirlpool Galaxy 12CO(1-0) emission observed with the Plateau de Bure interferometer.



CLASS data format was implemented to be able to support the SOFIA/GREAT multi-beam experiment.

After years of heavy hardware changes to install wideband receivers and backends at the Plateau de Bure interferometer, the year 2011 was pretty quiet. This allowed the software development group to further stabilize the data acquisition, calibration and imaging software packages. Work was also invested into implementing a water-vapor radiometer dual-channel mode in case the lowest frequency channel is unusable because of radio frequency interferences. The calibration pipeline was adapted to cope with band 4 observations, and error logging, robustness and easy of use were largely improved.

In the area of imaging and deconvolution, IRAM continued its research and development activities around the interferometric On-The-Fly observing mode in the framework of the European FP6 program "ALMA enhancement". The new imaging algorithm was thoroughly tested and found to work well, and according to expectations. The second half of the year was dedicated to defining and writing software specifications for NOEMA, the Plateau de Bure interferometer extension project.

All the software developments are based on the common GILDAS services, e.g. a set of common low-level libraries, collectively named GILDAS kernel, which take care of the scripting and plotting capabilities of GILDAS. Although efforts in this area are not necessarily visible to the outside world, they are extremely important for the evolution of the IRAM data reduction software. The large development effort started in 2010 to overhaul the graphical possibilities of GILDAS was released mid-2011. Another large effort was started in collaboration with the Observatoire de Bordeaux to adapt GILDAS to the almost exponential volume increase of data produced by current (FTS) and future instrumentation (multi-beam receivers, wide-bandwidth receivers, high resolution spectrometers, interferometric on-the-fly observations) at the IRAM telescopes.

Finally, a new project, named PMS (Proposal Managing System), was started to replace the current proposal submission and processing system for the IRAM 30m telescope and Plateau de Bure interferometer. The new system uses DRUPAL web technology and is planned to be brought on-line in 2013.

IRAM ARC node

IRAM staff is involved in several ALMA-related activities and software developments.

IRAM is deeply involved in the development of one of the key software for the real-time operations of ALMA, the Telescope Calibration (TelCal) software. This software is performing all real-time calibrations necessary to run the array: antenna pointing, focus, baseline measurements, atmospheric parameters, etc. Two IRAM engineers are working on this development. 2011 was a critical year for TelCal, as the array commissioning made large progresses, implying a continuous and important effort to correct, adapt, and further develop TelCal. In parallel, scientific observations (Early Science Cycle 0) were started, putting additional constrains on the performances and reliability of the real-time software. Finally, a stand-alone version of TelCal, interfaced to the CASA off-line package, is also being developed, to allow an off-line reprocessing of the real-time calibration. The contract between ESO and IRAM concerning TelCal has been renewed in 2011, and extends now (with decreasing manpower) up to the end of 2014.

The institute was involved in a workpackage of the EU-funded «ALMA Enhancement» program. In that context, a new wide-field imaging technique was developed during the last years to be able to properly process large maps obtained with on-the-fly interferometry. This technique is being implemented and tested in GILDAS. In 2011, the code was interfaced to the CASA data reduction software, providing a possibility to use this new algorithm on ALMA data.

IRAM and ESO have agreed on a scheme allowing IRAM astronomers to participate to the ALMA commissioning and science verification phase. Following that agreement, two IRAM astronomers spent three months each in Chile during 2011. This was an very fruitful experience, allowing the IRAM staff to acquire hands-on experience on the ALMA instrument and vice versa.

2011 was a pivotal year for the IRAM ARC node, as the ALMA project issued its very first Call for Proposals (Early Science Cycle 0). The ARC is the main contact point between ALMA and the community, and was thus directly involved in the start of the scientific operations. The IRAM ARC node organized a «proposal preparation» meeting and distributed various documentations, in order to help the IRAM community to prepare for this new instrument. With the start of the ALMA operations, the role of the ARC nodes was partly redefined, and new activities - initially attributed exclusively to the main ARCs - are now being carried out by astronomers in the ARC nodes. In particular, the ARC node staff acts as «Contact Scientists» for the accepted ALMA projects, i.e. providing expertise to check and validate the Scheduling Blocks that were created from the initial proposals. The same Contact Scientists will then support the actual data reduction when the data will be delivered to the PIs. The IRAM ARC node currently supports 14 projects out of the 35 accepted projects in Europe.

On the long term, having access to the Plateau de Bure/NOEMA and to the ARC node services should place the IRAM users community in the best possible position to get time on ALMA, in an extremely competitive environment.

ARC NODE

Annex I – Finances

Expenditure		
Budget heading	**Approved**	**Actual**
Operation/Personnel	8 136 637	8 203 465
Operation/Other items	3 739 798	3 734 294
Budgetary excess/loss	0	65 013
TOTAL OPERATION	**11 876 435**	**12 002 772**
Investment base	2 445 567	1 423 021
Investment NOEMA	9 595 267	1 933 043
Investment Cable Car	5 859 102	174 628
Investment NOEMA	1 000 000	4 732
Budgetay excess/loss		1 040 888

Income		
Budget heading	**Approved**	**Actual**
CNRS contributions	7 178 466	5 678 466
MPG contributions	5 678 466	5 678 466
IGN contributions	724 910	724 910
TOTAL CONTRIBUTION	**13 581 842**	**12 081 842**
Carry forward from previous years	5 161 399	
IRAM'own income	1 437 863	1 564 199
ANR EQUIPEX	1 000 000	1 000 000
TOTAL INCOME excl. VAT	**21 181 104**	**14 646 041**

Annex II – Telescope schedules

30-METER TELESCOPE

Ident.	Title of Investigation	Authors
057-09	Origins of molecular clouds and star formation in W43 - a large HERA project	Motte, Schilke, Nguyen, Schneider, Bontemps, Schuller, Menten, Wyrowski, Heitsch, Hennebelle, Banerjee, Kramer, Simon, Beuther, Henning, Bronfman, Walmsley, Zavagno
228-09	A Legacy Survey to Study Cold Gas Scaling Laws in the Local Universe	Kramer, Kauffmann, Buchbender, Catinella, Cortese, Fabello, Fu, Giovanelli, Gracia-Carpio, Guo, Haynes, Heckman, Krumholz, Li, Moran, Rodriguez-Fernandez, Saintonge, Schiminovich, Schuster, Sievers, Tacconi, Wang
146-10	Confirmation of the first detection of HNC on Titan	Moreno, Lellouch, Marten, Courtin, Bockelee-Morvan, Hartogh, Lara, Paubert
148-10	Toward a chemical evolutionary sequence in high-mass star formation	Beuther, Linz, Henning, Vasyunina, Semenov, Banerjee, Dullemond
151-10	Benchmarking grain-surface chemistry on the prototypical Horsehead PDR	Guzman, Pety, Bardeau, Belloche, Gerin, Goicoechea, Le Bourlot, Le Petit, Myake, Roueff, Sievers
154-10	Testing the new collisional rates for HNC	Padovani, Walmsley, Gerin, Tafalla, Caselli
155-10	Search for complex organic molecules in pre-stellar cores	Bacmann, Kahane, Ceccarelli, Taquet, Faure, Quirico, Ratajczak
156-10	Understanding outflow chemistry	Tafalla, Canay
157-10	Indirect determination of the O:O2 ratio in dark clouds	Hily-Blant, Pineau des Forêts, Maret, Bacmann, Faure
159-10	Isotopic ratios: A successful tool for tracing gas accretion in a barred potential model	Riquelme, Amo Baladrón, Martín-Pintado, Mauersberger, Martín, Pérez, Bronfman
163-10	Tracing Formation of Methanol by Observations of Its ^{13}C Isotopomer	Sakai, Sakai, Yamamoto
165-10	A Systematic Study of Deuteration in the Perseus COMPLETE Cores	Shirley, Tafalla, Johnstone, Schnee, Friesen, Rosolowsky
166-10	Search for deuterated methyl formate (DCOOCH3) in NGC1333-IRAS4A	Demyk, Bottinelli, Caux, Vastel, Coutens, Ceccarelli, Kahane, Taquet, Wakelam, Quirico, Ratajczak, Aikawa
168-10	Multiple deuteration of CH3CN in IRAS16293-2422	Du, Parise, Müller
169-10	C2H Zeeman measurements toward high-mass star-forming regions	Beuther, Linz, Henning, Crutcher
170-10	Polarization study of CN emission towards massive protostars: what is the role of the magnetic field?	Herpin, Bontemps, Wiesemeyer, Motte, Jacq, Schneider, Csengeri
172-10	A Disk Dynamo in MWC349?	Thum, Wiesemeyer, Morris
174-10	CN Zeeman Observations of High-Mass Star Forming Regions	Falgarone, Crutcher, Troland, Hily-Blant
176-10	The Best Candidate of the Rescaled Low-Mass Star Forming Core	Liu, Ho, Zhang, Li
177-10	A systematic study of the chemical evolution of starless cores	Tafalla, Canay
180-10	Formation of prestellar cores from velocity-coherent subsonic filaments	Hacar, Tafalla
181-10	Molecular fingerprints of an unbiased sample of Galactic MSF clumps	Wyrowski, Schuller, Menten, Bontemps, Herpin, Schilke, Beuther, Walmsley, Motte, Garay, Zavagno, Wienen, Quang
182-10	Gas depletion and dust properties in dense cores: IRAM complements Herschel	Stutz, Launhardt, Bieging, Henning, Kainulainen, Krause, Linz, Nielbock, Ragan, Schmalzl, Steinacker
185-10	IRAM-30m follow-up of cold cores detected by the Planck satellite	Pagani, Ristorcelli, Juvela, Bernard, Giard, Mény, Marshall, Montier, Harju, Malinen, Laureijs, Mcgehee, Paladini, Pelkonen, Toth
187-10	Probing the earliest stages of protocluster dynamical evolution	Peretto, André, Arzoumanian, Hennebelle, Konyves, Schneider, Attard
188-10	Studying the physical and chemical conditions of Orion waves	Marcelino, Berné, Cernicharo, Goicoechea
189-10	The chemical structure of Orion: Completion of the 2-D line survey at 1mm	Marcelino, Cernicharo, Bañó, Palau, Tercero, Guelin
190-10	An Unbiased Spectral Survey of the Protostellar Bowshock L1157-B1	Lefloch, Ceccarelli, Gueth, Cernicharo, Codella, Benedettini, Cabrit, Schuster, Vasta
191-10	Molecular gas orbiting the nearest classical T Tauri stars	Kastner, G Sacco, Forveille, Hily-Blant, Zuckerman
193-10	Molecular Complexity in the Intermediate-Mass Protostellar Outflow Cep E	Pacheco, Lefloch, Ceccarelli, Cernicharo, Cabrit, Fuente
198-10	The magnetic precursor in molecular outflows (II)	Roberts, Jiménez-Serra, Gusdorf, Martín-Pintado, Rodríguez-franco, Viti
199-10	Water in intermediate mass star forming regions	Cernicharo, Fuente, Agúndez, Alonso-Albi, Bachiller, Beltrán, Bonnell, Busquet, Caselli, Cabrit, Castro-Carrizo, Cesaroni, Codella, Estalella, Fich, Fontani, Girart, Goicoechea, Herpin, Johnstone, Lefloch, Marcelino, Mccoey
200-10	Probing the nature of Mid-IR Extended Green Objects	Gomez-Ruiz, Wyrowski, Menten
205-10	Structure of S156 high-mass star-forming region	Pirogov, Vasyunina, Linz, Zinchenko

Ident.	Title of Investigation	Authors
206-10	Massive outflows in W3 Main - short spacing complement to the SMA	Wang, Beuther, Bik, Zhang
207-10	$H^{13}CO^+$ 3-2 toward disks imaged in HCO^+ 3-2	Öberg, Qi, Wilner, Bergin, Fogel, Andrews, Espaillat, Pascucci
208-10	A search for water in protoplanetary disks	Cernicharo, Ceccareli, Fuente, Agúndez, Goicoechea, Lefloch
209-10	Complementing Herschel/DUNES data of four debris disks with MAMBO-2	Ertel, Wolf, Eiroa, Augereau, Krivov, Liseau, White, Marshall, Danchi, Mora, Fridlund, Pilbratt
212-10	Molecular complexity in O-rich evolved stars: OH231.8+4.2 and IK Tau	Sanchez Contreras, Alcolea, Cernicharo, Bujarrabal, Agundez, Herpin, Pardo, Menten, Wyrowsky
213-10	Radio Probing of the AGB Wind-ISM Interface Regions around R Hya	Ueta, Alcolea, Bujarrabal, Szczerba
214-10	A lambda 0.9 mm spectral line survey of IRC+10216	Kahane, Cernicharo, Guélin, Agúndez, Pardo
216-10	Study of the bow-shock and the mass-loss variations around IRC+10216	Quintana-Lacaci, Cernicharo
217-10	PDR and SN-driven chemistry in the Galactic center	Amo Baladrón, Riquelme, Martín-Pintado, Martín, Requena-Torres
220-10	A search for very high velocity gas around SgrA*	Lefloch, Cernicharo, Ceccarelli, Cox
221-10	The stability of the Galactic Circumnuclear Disk	Rodriguez-Fernandez, Vollmer, De Vicente, Braine, Trippe
222-10	Nature of the Molecular Gas in Cool-Core Galaxy Groups/Clusters: NGC 5044	Lim, Sun, Edge, Combes, Salomé, Dinh-v-Trung, Ohyama
223-10	The Star Formation - Molecular Gas Connection in an Extended UV Disk	Watson, Martini, Böker, Gil De Paz, Lisenfeld, Schinnerer
225-10	The complete CO(2-1) map of M33	Braine, Schuster, Kramer, Gonzalez, Sievers, Rodriguez, Gratier, Brouillet, Herpin, Bontemps, Israel, Van Der Werf, van der Tak, Tabatabaei, Henkel, Roellig, Combes, Wiedner
228-10	EMIR ^{12}CO and ^{13}CO maps of M83	Abreu, Kramer, García-Burillo, Israel, Lord, Güsten, Torres
229-10	Molecular shocks in the Stephan's Quintet	Usero, García-Burillo, Verdes-Montenegro, Fuente, Sulentic
230-10	Star formation and shocks in head-on colliding galaxies	Usero, García-Burillo, Fuente, Brinks
231-10	Chemistry differences between the outflow and the streamers in M 82	González-García, García-Burillo, Fuente
232-10	Feedback where it matters most: CR-dominated regions in extreme starbursts	Papadopoulos, Bayet, Greve, Henkel, Viti, Weiss, Spaans
233-10	A Dedicated Line Survey of Mrk 231 - Part II	Henkel, Aladro, Ao, Van Der Werf, Gonzalez-Alonso, Weiss, Martín-Pintado, Aalto, Roberts
234-10	Hot molecular gas near the AGN of NGC 1068	Mühle, Henkel, Aalto
237-10	Cold dust along the major axis of the spiral galaxy M33 - the HERMES project.	Quintana-Lacaci, Kramer, Sievers, Buchbender, Tabatabaei, Akras, Xilouris, Aalto, Bertoldi, Anderl, Braine
245-10	Molecules and dust in Virgo galaxies detected by Herschel	Bianchi, Corbelli, Giovanardi, Magrini, Clemens, Gavazzi, Hunt, Sabatini, Baes, Delooze, Verstappen, Fritz, Garcia-Appadoo, Boselli, Jones, Madden, Bomans, Pierini, Zibetti, Xilouris, Grossi, Vlahakis, Davies, Cortese, Hughes, Bendo, Dariush, Pohlen, Smith, Fadda
246-10	The chemical classification of galaxies.	Aladro, Martín, Riquelme, Martín-Pintado, Kramer, Güsten, Mauersberger, Weiss, Requena-Torres, Armijos
249-10	Excitation of Dense Molecular Gas in Galaxy Nuclei	Israel, Meijerink, Loenen
250-10	Molecular Tracers of Galaxy Evolution II: Chemistry or Excitation?	Costagliola, Aalto, Spoon, Van Der Werf, Muller, Jütte, Lahuis, Martín Ruiz, Rodríguez
251-10	First systematic CS 5-4 survey toward LIRG/ULIRGs with the IRAM 30m	Zhang, Gao, Henkel, Wang
255-10	Characterising the influence of galaxy activity on the properties of the densest molecular gas component	Bayet, Viti, Martín-Pintado, MartÌn-Pintado, Martín, Martín Ruiz, Aladro, Topal
257-10	Search for the 57Fe XXIV hyperfine-structure line in Abell 85 & 426	Greve, Morris, Kramer
258-10	Coordinated cm to mm-monitoring of variability and spectral shape evolution of a selected Fermi blazar sample	Fuhrmann, Zensus, Nestoras, Krichbaum, Angelakis, Marchili, Ungerechts, Sievers, Riquelme, Readhead
260-10	A search for CO emission from low redshift blazars	Dessauges-Zavadsky, Furniss, Fumagalli, Prochaska, Williams
261-10	Are FeLoBALs in a 'transition phase' between a ULIRG and a QSO?	Coppin, Farrah, Hall, Lacy, Smail, Alexander, Seymour, Benn
265-10	On the Road to Understanding AGN Feedback	Lehnert, Boulanger, Pineau des Forêts, Herrera, Nesvadba, Guillard, Appleton, Ogle
266-10	3 & 1 mm polarimetric monitoring of 14 bright gamma-ray blazars	Agudo, Thum, Wiesemeyer, Gómez, Molina, Marscher, Jorstad
268-10	Towards Imaging the Event Horizon - 1mm VLBI Studies of Sgr A* and AGN-jets	Krichbaum, Bremer, Trippe, Sanchez, Roy, Alef, Graham, Zensus, Güsten, Menten, Al., Doeleman, Lindqvist, Ziurys, Strittmatter
269-10	Galaxy Evolution and Star Formation Efficiency at $0.6 < z < 1$.	Combes, García-Burillo, Braine, Schinnerer, Walter, Colina
271-10	Physics of Gas and Star Formation in Galaxies at z=1.2	Combes, Tacconi, Genzel, Bolatto, Bournaud, Burkert, Cooper, Cox, Davis, Schreiber, García-Burillo, Gracia-Carpio, Lutz, Naab, Neri, Newman, Sternberg, Weiner
272-10	CO and CI in Intermediate Redshift ULIRGs	Boone, Lim, Gerin, Bayet, Papadopoulos, Trung, Matsushita, Muller
274-10	Molecular gas in the cores of distant, X-ray luminous clusters	Edge, Salome, Ebeling, Hamer, Allen, Ehlert, Mcnamra, Cavagnolo

Ident.	Title of Investigation	Authors
277-10	A candidate protocluster at z~2: star formation and radio activity at high redshift	Andreani, Magliocchetti, De Zotti, Danese, Gruppioni, Zwaan, Hatziminaoglou
278-10	MAMBO observations of the most luminous HerMES sources	Perez-Fournon, Oliver, Beelen, Bock, Burgarella, Cava, Chapman, Clements, Conley, Cooray, Cox, Dowell, Dunlop, Farrah, Ferrero, Glenn, Gonzalez-Solares, Ivison, Krips, Neri, Omont, Rigopoulou, Roseboom, Vaccari, Vieira, Visus
279-10	Searching for a dusty galaxy towards a z=0.975 galaxy cluster	Johansson, Basu, Bertoldi, Burkutean, Sommer, Horellou, Fassbender, Böhringer, Lee, Holzapfel, Johnson, Reichardt, Richards, Westbrook, Halverson, Bender, Dobbs, Kennedy
280-10	MAMBO snapshots: Obtaining the flux at 1.2mm of the Brightest Herschel-Selected Submm-Galaxies beyond z ~2-5	Dannerbauer, Omont, Perez-Fournon, Aretxaga, Beelen, Bertoldi, Bethermin, Cava, Clements, Cooray, Coppin, Cox, Daddi, De Zotti, Dunlop, Dunne, Eales, Frayer, Glenn, Hughes, Ivison, Jarvis, Krips
281-10	Dust emission from lensed galaxies within and after the Epoch of Reionization	Boone, Schaerer, Pelló, Combes, Dessauges-Zavadsky, Semelin
282-10	Dissecting the nature of the Planck-HFI cold and bright high-latitude submillimeter sources: a flux-limited sample.	Dole, Montier, Lagache, Beelen, Giard, Omont, Pointecouteau, Puget, Tristram, Welikala
283-10	Mapping a z=5 Cluster in Far-IR Emission	Bremer, Stanway, Davies, Omont, Lehnert
286-10	Searching CO in WISE-Selected Hyperluminous Galaxies	Wu, Tsai, Benford, Eisenhardt, Bridge, Blain, Lin
287-10	Galaxy clustering in the Early Universe	Lestrade, Combes, Salomé, Omont, Bertoldi
288-10	Atomic carbon in massive galaxies beyond redshift 4	König, Greve, Seymour, De Breuck, Ivison
294-10	Cooling at Early Times - [CII] in a Unique High Redshift Source	Stanway, Bremer, Davies, Omont, Lehnert
295-10	A CO redshift for the most mm luminous starburst galaxy: MMJ1541+6630	Wagg, Bertoldi, Owen, Carilli, Menten
296-10	Revealing the CO line emission of a submm-bright galaxy at z~4.5	Aravena, Schinnerer, Sheth, Bertoldi, Carilli
298-10	The HH7 bow shock: A benchmark for shock models	Gratier, Cabrit, Gerin, Lesaffre, Pety, Pineau des Forêts
303-10	Formation and Evolution of Circumnuclear Starburst Rings II Dense Gas	Van Der Laan, Schinnerer, Emsellem, Dumas, Mundell, Wozniak, Haan, Böker
D01-10	Planck cold cores	Pagani
D03-10	Short spacings for N062	Güsten
D04-10	Dust emission of z=6.04 SDSS quasar	Wang
D05-10	A search for HeH^+ and CH at high redshifts	Zinchenko, Dubrovich, Henkel
D08-10	Unraveling the enigmatic nature of the wind-ISM interaction around Betelgeuse	Decin, Cernicharo, Cox, Groenewegen, Royer, Teyssier, Jan Van Marle, Verhoelst
001-11	Probing the composition of comet C/2010 X1 (Elenin)	Biver, Crovisier, Bockelée-Morvan, Colom, Moreno, Hartogh, Lis, Boissier, Paubert, Weaver, Russo, Vervack
003-11	Investigating the nitrogen isotopic fractionation mechanism in cold quiescent clouds: search for $N^{15}NH^+$ and $^{15}NNH^+$ in L694-2	Bizzocchi, Caselli, Dore
004-11	Benchmarking grain-surface chemistry on the prototypical Horsehead PDR	Guzman, Pety, Bardeau, Belloche, Gerin, Goicoechea, Gratier, Le Bourlot, Le Petit, Roueff, Sievers
005-11	On the origin of CO desorption in dark clouds and YSOs	Muñoz Caro, Escobar, Roberts, Pintado, Thi
007-11	The potential of the NCO molecule to determine the O:O2 ratio	Hily-Blant, Pineau des Forêts, Maret, Bacmann, Faure
008-11	Search for complex organic molecules in pre-stellar cores	Bacmann, Kahane, Taquet, Ceccarelli, Faure, Quirico, Ratajczak
009-11	Cosmic-ray induced chemistry in strongly irradiated molecular clouds	Ceccarelli, Hily-Blant, Montmerle, Lefloch, Dubus, Kahane, Wiesenfeld
010-11	Understanding the hydrocarbon emission in the archetype solar-type protostar IRAS16293-2422	Coutens, Bottinelli, Caux, Ceccarelli, Demyk, Kahane, Sakai, Vastel, Wakelam, Yamamoto
011-11	Complexity of star formation: the case of the intermediate mass protostar OMC2-FIR4	Ceccarelli, López-Sepulcre, Kama, Lefloch, Fuente, Caselli, Caux, Dominik, Kahane, van der Tak, Wiesenfeld
012-11	Chemical evolution, ionization fraction and cosmic ray ionization rate during molecular cloud formation	Gerner, Beuther, Glover, Linz, Henning, Semenov, Banerjee, Dullemond
013-11	Organic molecules in the L1157 protostar	Rodriguez-Fernandez, Ceccarelli, Lefloch, Bacmmann, Kahane, Bottinelli, Caux, Gueth, Codella
014-11	Energetic processing driven chemistry: C2O and C3O	Palumbo, Bottinelli, Buemi, Caux, Ceccarelli, Leto, Trigilio, Umana
017-11	Probing N_2D^+ in Infrared Dark Clouds: A clue to the ionization degree	Vasyunina, Herbst, Linz, Beuther, Tackenberg, Zinchenko, Pirogov, Henning
020-11	Deuterated water chemistry towards high-mass star-forming regions.	Vastel, Gérin, Coutens, Comito, Jastrzebska, Lis, Goldsmith, Herbst, Faure
022-11	Isotopic ratios: A successful tool for tracing gas accretion in a barred potential model	Riquelme, Amo-Baladrón, Martín-Pintado, Mauersberger, Martín, Pérez, Bronfman
023-11	A Systematic Study of Deuteration in the Perseus COMPLETE Cores	Shirley, Tafalla, Johnstone, Schnee, Friesen, Rosolowsky
024-11	Comparison of turbulent dissipation in two nearby molecular clouds	Hily-Blant, Falgarone, Hennebelle, Lesaffre, Clabaud
025-11	C_2H Zeeman measurements: Characterizing the beam squint	Beuther, Linz, Henning, Crutcher
026-11	Probing the evolution of turbulence in a sample of Aquila filaments	André, Arzoumanian, Peretto, Maury, Könyves, Menshchikov, Didelon

Ident.	Title of Investigation	Authors
027-11	A chemo-dynamical study of dense molecular cores: from Herschel to IRAM	Lippok, Stutz, Launhardt, Schmalzl, Henning, Beuther, Kainulainen, Krause, Linz, Nielbock, Semenov
031-11	Chasing depleting-resistant species in prestellar cores	Padovani, Walmsley, Tafalla, Hily-Blant, Pineau des Forêts, Lique, Jorfi, Dumouchel
033-11	CCH exploratory study toward the magnetized Pipe Nebula Starless Cores	Frau, Padovani, Girart, Beltrán, Morata, Alves, Franco, Busquet, Estalella, Masqué, Sánchez-Monge
038-11	Dynamical study of the magnetized "Snake" Nebula (is it an "Eel"?)	Frau, Girart, Franco
039-11	An Unbiased Spectral Survey of the Protostellar Bowshock L1157-B1	Lefloch, Ceccarelli, Gueth, Cernicharo, Codella, Benedettini, Cabrit, Schuster, Vasta
040-11	Origin of Water in Deeply Embedded Low-Mass Protostars	Persson, Jorgensen, Kristensen, Arce, Tafalla
041-11	The outflow phenomenon at the substellar boundary	Monin, Lefloch, Dougados, Whelan, Cabrit, Oliveira
042-11	The high velocity CO component toward the prestellar core L1544	Caselli, Tafalla, Pagani, Keto, Aikawa, Bergin, Yildiz, van der Tak, Codella, Nisini
043-11	Molecular Complexity in the Intermediate-Mass Protostellar Outflow Cep E	Pacheco, Lefloch, Ceccarelli, Cernicharo, Cabrit, Fuente
050-11	Revealing the inner structure of the Cep A HW2 jet	Báez-Rubio, Jiménez-Serra, Martín-Pintado, Thum, Rodríguez-franco
051-11	Observations of $C_{18}O$ J = 1-0 & 2-1: A Direct Method to Obtain Total Column Densities in Hot Cores	Plume, Caux, Bergin, Lis., Cernicharo, Menten, Schilke., Stutzki, Wang
053-11	Toward a chemical evolutionary sequence in high-mass star formation	Beuther, Gerner, Linz, Henning, Vasyunina, Semenov, Banerjee, Dullemond
054-11	Vertical Stratification of Turbulence in Protoplanetary Disks II: 30m survey	Dutrey, Guilloteau, Henning, Wakelam, Hersant, Semenov, Chapillon, Launhardt, Pietu, Schreyer, Gueth
056-11	Nitrogen Chemistry in Proto-Planetary Disks	Dutrey, Guilloteau, Wakelam, Hersant, Henning, Semenov, Hincelin, Boehler, Chapillon, Launhardt, Pietu, Schreyer, Gueth
058-11	SiO maser emission from red supergiants.	Messineo, Menten, Kamiński
060-11	PN Density Profiles and AGB Mass-loss History	Verbena, Schröder, Wachter, Winters
063-11	Unveiling the rich chemistry of yellow hypergiant stars: IRC+10420	Quintana-Lacaci, Bujarrabal, Castro-Carrizo, Sánchez-Contreras, Alcolea
067-11	Mapping the molecular inner ring of M31	Melchior, Combes
068-11	EMIR ^{12}CO and ^{13}CO maps of the M83 central bar (resubmission)	Abreu Vicente, Kramer, García-Burillo, Israel, Lord, Güsten, Billot
070-11	Tracing gas accretion in barred galaxies using isotopic ratios	Riquelme, Martín-Pintado, Aladro, García-Burillo, Perez, Amo-Baladrón, Mauersberger, Martín
071-11	A chemical study of the giant molecular halo of M 82	González-García, García-Burillo, Fuente, Usero, Aladro
076-11	Star formation and shocks in head-on colliding galaxies	Usero, García-Burillo, Fuente, Brinks
077-11	Unleashing the ISM chemistry in isolated galaxies	Martín, Verdes-Montenegro, Aladro, Espada, Kramer, Scott
080-11	Stripping galaxies: Extent and kinematics of shock-heated CO in compact groups	Lisenfeld, Appleton, Cluver, Guillard, Ogle
081-11	Are mid-IR spectral signatures of pressure-confined star formation an aspect of major merger mode star formation in galaxies?	Spoon, Aalto, Costagliola, Farrah, Garcia-Burillo, Graciá-Carpio, Lahuis, Pérez-Beaupuits, Spaans, Tielens
082-11	Galaxy Evolution and Star Formation Efficiency at $0.6 < z < 1$.	Combes, García-Burillo, Braine, Schinnerer, Walter, Colina
083-11	The Molecular Gas Content of $z <= 0.3$ Palomar-Green QSO Hosts	Evans, Barthel, Tacconi, Sanders, Frayer, Surace, Hines, Kim
085-11	CO and Star Formation in Gas-dominated Massive Galaxies	Saintonge, Haynes, Huang, Giovanelli, Adams, Brinchmann, Chengalur, Hallenbeck, Masters, Spekkens
086-11	Search for CO emission in ram pressure stripped Virgo galaxy IC3418	Jachym, Kenney, Gorkom, Combes
087-11	Calibrating Molecular Gas Diagnostics in Low-Metallicity Galaxies	Schruba, Walter, Sandstrom, Leroy, Bigiel
090-11	CN: ideal diagnostic tool for extra-galactic ISM?	Loenen, Meijerink, Baan, Israel, Van Der Werf, Spaans
092-11	Molecular Gas Observations of Luminous Infrared Galaxies in the Great Observatories All-sky LIRG Survey (GOALS)	Iwasawa, Evans, Aalto, Frayer, Pérez-Torres, Herrero-Illana, Surace, Privon, Kim, Mazzarella, Armus, Spoon
096-11	The CS/HCN ratio as a tracer of metallicity in early-type galaxies	Davis, Bayet, Crocker, Bureau
099-11	Gas Density and Environment in Nearby Galaxies	Usero, Leroy, Walter, Sandstrom, Bigiel, Schruba, Brinks, Kramer, Schuster
102-11	Coordinated cm to mm-monitoring of variability and spectral shape evolution of a selected Fermi blazar sample	Fuhrmann, Zensus, Nestoras, Krichbaum, Angelakis, Schmidt, Marchili, Ungerechts, Sievers, Riquelme, Readhead
106-11	Monitoring AGN with Polarimetry at the IRAM-30 m-Telescope	Agudo, Thum, Wiesemeyer, Gómez, Molina, Marscher, Jorstad
107-11	Dense nuclear gas tracers in nearby AGN templates	Sacchi, Busquet, Spinoglio, Alfonso
108-11	A search for CO emission from low redshift blazars	Fumagalli, Walter, Dessauges-Zavadsky, Furniss, Prochaska, Williams
114-11	The Connection Between [CII] and Star Formation Mode at z~1-2	Hailey-Dunsheath, Stacey, Nikola, Ferkinhoff, Graciá-Carpio
115-11	A Full Budget of the CO in a Strong [CII]-Emitter at z~1.3	Hailey-Dunsheath, Stacey, Nikola, Ferkinhoff, Swinbank
116-11	Detection of CO in a unique multiply imaged lensed spiral galaxy at z=1	Boone, Richard, Dessauges, Rex, Schaerer, Pello, Combes, Egami, Zamojski, Blain, Omont, Kneib

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120-11	Molecular gas in high-redshift (z>4) submillimeter galaxies	Smolvcic, Weiss, Ilbert, Navarrete, Aravena, Bertoldi, Schinnerer, Karim, Yun, Aretxaga
121-11	New strongly lensed galaxies representative of the high-*z* star forming population	De Zotti, González-Nuevo, Andreani, Lapi, Maiolino, Danese, Negrello, Dannerbauer, Omont, Rodighiero, Fan, Serjeant, Birkinshaw, Clements, Smail, Michalowski, Wardlow, Dye
124-11	CO rotational ladders of lensed high-*z* galaxies discovered by Herschel	Van Der Werf, Omont, Ivison, Cox, Swinbank, Smail, Dannerbauer, Bertoldi, Eales, Cooray, Leeuw, Ibar, Vaccari, Coppin, Dunlop, De Zotti, Harris, Baker, Aretxaga, Verma, Hughes, Frayer, Meijerink, Loenen, Berciano, Krips, Kramer, Lupu, Rigopoulou
125-11	Probing the atomic carbon gas reservoir in a massive radio galaxy at *z*=4.11	König, Greve, Seymour, De Breuck, Ivison, Rawlings
D02-11	Revealing the CO line emission of a submm-bright galaxy at z~4.5	Aravena, Smolcic, Weiss, Schinnerer, Bertoldi, Sheth, Carilli
D03-11	Confirmation of the detection of O_2H	Parise, Bergman, Du

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Ident.	Title of Investigation	Authors
O04E	Deep study of the circumstellar envelopes of AGB & early post-AGB stars	Castro-Carrizo, Alcolea, Bujarrabal, Grewing, Lucas, Neri, Oloffson, Schöier, Winters, Lindqvist
S039	Gas Fractions and Star Forming Histories of Galaxies at *z*=1-1.5	Genzel, Tacconi, Davis, Cooper, Schreiber, Shapiro, Bolatto, Weiner, Lutz, Gracia-Carpio, Comerford
S0D7	Star Forming Histories and Gas Fractions of Galaxies from *z*=1-3	Genzel, Tacconi, Davis, Bolatto, Bournaud, Burkert, Combes, Cooper, Cox, Schreiber, Garcia-Burillo, Gracia-Carpio, Lutz, Naab, Neri, Omont, Shapiro, Shapley, Sternberg, Weiner
T062	Completing the study of the protocluster IC 1396-N	Fuente, Alonso-Albi, Beltran, Castro-Carrizo, Ceccarelli, Codella, Lefloch, Neri
T078	Origin of High-velocity CO in DG Tau	Codella, Cabrit, Guedel, Gueth, Cesaroni, Dougados
T07B	The structure of the "Butterfly Star's" famous edge-on disc with high resolution	Sauter, Wolf, Dutrey, Guilloteau, Boehler
T0B2	Where are the sites of active star formation in the Lyα blob LAB1?	Dannerbauer, Walter, Tapken, Yang, Matsuda, Yamada, Hayashino
T0B7	The Spatially Resolved Star Formation Law in Clustered z>4 Submm Galaxies	Riechers, Daddi, Carilli, Walter, Morrison, Krips, Dannerbauer, Elbaz
T0B9	Mapping the gas metallicity in a distant protogalaxy	Maiolino, Lutz, Neri, Nagao, Caselli, de Breuck, Genzel, Tacconi, Walmsley
T0C5	The [CII]-forest: a new powerful tool for cosmology	Maiolino, Gallerani, Ferrara, Lutz, Genzel, Tacconi
U--2	Detecting stellar outflow feedback in a spectacular rotating-clump cluster galaxy	Genzel, Tacconi
U--4	Confirmation of the first example of a pre-brown dwarf	André, Greaves, Motte, Ward-Thompson
U003	Methyl formate and methanol: two key complex organic molecules	Taquet, Ceccarelli, Kahane, Neri, Ratajczak, Faure, Lefloch, Pacheco, Bacmann, Quirico, Wiesenfeld, Szalewicz
U038	CO excitation conditions in 1<z<2 QSOs	Krips, Neri, Cox, Beelen, Barvainis, Riechers, Walter
U044	Search for CH^+(1-0) absorption in high-*z* galaxy haloes	Falgarone, Bournaud, Cox, Elbaz, Godard, Hily-Blant, Neri, Nurit, Omont, Phillips
U049	Molecular Gas in the Largest Spectroscopically Confirmed Sample of z > 4 SMGs	Karim, Schinnerer, Carilli, Bertoldi, Capak, Smolcic
U052	Class 0 protostars with PdBI: Solving the angular momentum problem?	André, Maury, Testi, Launhardt, Codella, Cabrit, Gueth, Lefloch, Maret, Bottinelli, Bacmann, Belloche, Bontemps, Hennebelle, Klessen, Dullemond
U--7	Hi-res imaging of CII in ATLAS15-141	Cox, Krips, Neri, Omont
U--8	Hi-res imaging of H_2O in ID 17	Cox, Krips, Neri, Omont
U--9	H_2O emission as a new probe of the ISM in high-*z* galaxies	van der Werf, Alba, Walter, Weiss, Spaans, Loenen, Meijerink, Riechers
U--A	Molecular Outflow in NGC3079	Davies, Sternberg, Graciá-Carpio, Tacconi, Sani, Orban de Xivry, Sturm
U--B	Detecting the Starburst in a Spectroscopically Confirmed Quasar Host Galaxy at *z*=7.1	Venemans, Walter, Warren, McMahon, Mortlock, Hewett, Simpson
U--C	Redshift determination of G9-40 from CO lines	Ivison, Cox, Neri, Krips
U--D	DDT proposal: Overluminous HCO^+ in the powerful molecular outflow of Mrk231	Aalto, García-Burillo, Costagliola, van der Werf, Henkel
U--E	H_2O in a 2nd strongly lensed Herschel source at *z*=3.254	Omont, Lupu, Ivison, van der Werf, Neri, Guélin, Cox, Clements, Weiss, Beelen, Lehnert, Krips, Dannerbauer, and the H-atlas team
U--F	The nature of the unique source SWIFT J 164449.3+573451 at z = 0.35 (DDT-ToO)	Castro-Tirado, Bremer, Winters, Gorosabel, Guziy, Thöne, de Ugarte Postigo, Castro Cerón, Sánchez-Ramírez, Tello
U056	The HH7 bow shock: A benchmark for shock models	Gratier, Cabrit, Gerin, Lesaffre, Pety, Pineau des Forêts

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U058	Dust emission in the L1157 outflow	Gueth, Bachiller, Codella, Guilloteau, Rodriguez-Fernandez, Tafalla
U05A	Kinematics of cold gas within Massive Dense Cores forming high-mass stars	Csengeri, Schneider, Motte, André, Bontemps, Herpin, Gueth, Hennebelle
U061	Origin of Water in Low-Mass Protostars	Persson, Jørgensen, van Dishoeck
U065	Disecting high-mass accretion disks: The power of the upgraded PdBI	Beuther, Linz, Henning
U06B	Mapping grain growth and cold CO gas in a massive transition disc	Ménard, Thi, Williams, Mathews
U06C	Resolving the inner dust holes in UX Tau A and SU Aur	Brown
U06D	Are faint protoplanetary disks just smaller rather than more tenuous?	Piétu, Guilloteau, Dutrey, Boehler
U06E	The geometrical location of CN in Protoplanetary Discs	Guilloteau, Henning, Dutrey, Chapillon, Semenov, Wakelam, Launhardt, Piétu, Schreyer, Boehler, Hincelin
U06F	Mind the Gap: Planet Formation in the LkCa 15 Disk	Andrews, Wilner, Dullemond
U070	Warm HCN in the planet-formation zone (R<50 AU) of GV Tau	Fuente, Cernicharo
U075	Bipolar flows and tori in low outflow-velocity AGB stars	Libert, Winters, Neri, Pety, Le Bertre, Gérard
U07D	High Resolution Imaging of Dense Gas in Individual Clouds in M 33	Buchbender, Kramer, Quintana-Lacaci, Gonzalez-Garcia, García-Burillo, Bertoldi, Anderl, Mookerjea, Braine, Gratier
U07F	The molecular gas reservoir in M82: how much 'fuel' is left 'undisturbed'?	Fuente, García-Burillo, Gerin, Krips, Neri, Usero, Pilleri
U080	Physical properties and kinematics of the ionized gas in the starburst M82	Viallefond, Uson, Torchinsky, Boone
U082	Physical conditions in the interstellar medium of early-type galaxies	Bureau, Topal, Bayet, Krips, Crocker, Young, Blitz, Combes, Davis, Alatalo, Cappellari, Emsellem, Krajnovic, McDermid, and the ATLAS^{3D} team
U085	Gas and Dust in the inner 60pc of NGC6946's Nuclear Starburst	Schinnerer, Böker, Emsellem, Meier
U087	Probing star formation laws in an extreme starburst: NGC 1614	García-Burillo, Alonso-Herrero, Combes, Graciá-Carpio, Colina, Hunt, Tacconi, Neri, Planesas, Arribas
U088	High resolution observations of optically thin dense gas tracers in Arp 220	Graciá-Carpio, García-Burillo, Sturm, Fischer, Alfonso, Planesas, Neri, Usero, Hailey-Dunsheath
U08A	Physical Properties of the Dense Gas close around nearby AGN	Davies, Sternberg, Graciá-Carpio, Sani, Orban de Xivry, Engel
U092	Probing AGN feedback in radio galaxies	García-Burillo, Combes, Usero, Fuente, Hunt, Neri, Boulanger, Nesvadba
U093	A search for radio-jet driven molecular outflow from 3C305	Guillard, Boulanger, Nesvadba, Ogle, Salomé, Emonts, Appleton
U094	Polarization conversion and the magnetic field geometry of 3C84	Trippe, Bremer, Krichbaum, Krips, Neri, Piétu, Winters
U095	Broad CO in local obscured quasars	Feruglio, Maiolino, Piconcelli, Fiore, Aussel, Le Floc'h, Elbaz
U097	Galaxy Evolution and Star Formation Efficiency in the second Half of the Universe	Combes, García-Burillo, Braine, Schinnerer, Walter, Colina
U09A	SFR suppression in distant galaxies through bulge-driven feedback	Salmi, Daddi, Bournaud, Elbaz, Martig, Dickinson, Salim
U09D	CO and continuum emission in the QSO host galaxy 3C48: Studying the evolutionary transition between ULIRGs and QSOs	Krips, Eckart, Neri, König
U09E	An Exploratory Redshift Survey in the Hubble Deep Field North	Walter, Carilli, Daddi, Cox, Riechers, Decarli, Bertoldi, Weiss, Neri, Menten, Dannerbauer, Bell, Dickinson, Ellis, Chiu, Krumholz, Robertson
U0A1	Cross-calibrating masses of quasar host galaxies	Jahnke, Walter, Decarli, Riechers
U0A2	Connecting Bright [CII] to Extended Star Formation at z = 1-2	Hailey-Dunsheath, Stacey, Nikola, Ferkinhoff, Engel
U0A5	High excitation gas in normal *z*=1.5 star forming galaxies	Daddi, Bournaud, Carilli, Dannerbauer, Dickinson, Elbaz, Krips, Riechers, Walter
U0AA	Hi-res imaging of a uniquely bright sample of SMGs	Cox, Ivison, Bertoldi, Cooray, Dannerbauer, Eales, Frayer, Jarvis, Krips, Leeuw, Negrello, Neri, Omont, Pérez-Fournon, Smail, Swinbank, van der Werf, Verma
U0AB	Detecting Molecular Gas in a *z*=2.07 Cluster	Gobat, Daddi, Onodera, Finoguenov, Renzini, Brusa, Cimatti, Carollo, Dannerbauer
U0B2	Probing the high-*z* star formation law with lensed galaxies at z~2	Livermore, Bower, Swinbank, Richard, Smail, Edge, Crain
U0B3	H_2O in a strongly lensed Herschel source at *z*=2.3	Omont, Beelen, Guélin, Neri, Krips, Cox, Bertoldi, Weiss, Lehnert, Dannerbauer, Michalowski, van der Werf, Ivison, Lupu, Leeuw, Cooray, Clements, Swinbank, Verma, Hughes, de Zotti, Smail, Jarvis, Temi, Coppin, Fiolet, Cons.
U0B4	Dense Molecular Gas at *z*>2: Submillimeter Water Emission	Riechers, Walter, Carilli, Cox, Weiss
U0B6	The ^{13}CO ladder in SMM J2135-0102	Swinbank, Smail, Cox, Danielson, Edge, Harris, Ivison, Krips, Neri
U0BB	High-resolution mapping of a multi-component submillimeter galaxy	Sharon, Baker, Harris, Lutz
U0BD	On the Variations of Fundamental Constants and AGN feedback	Weiss, Walter, Downes, Henkel, Menten, Carilli, Cox
U0BE	Connecting QSOs and Submillimetre Galaxies.	Smail, Swinbank, Danielson, Cox, van der Werf, Bonfield, Jarvis, Coppin, Ivison, Hughes, Vaccari, Dunlop, Verma, Clements, Leeuw, Smith
U0BF	High Resolution Imaging of Lock01, An High Redshift Lensed Submillimeter Galaxy at *z*=2.9	Beelen, Omont, Neri, Krips, Pérez-Fournon, Gavazzi, Aussel, Cooray, Bock, Clements, Conley, Dowell, Ivison, Lupu, Oliver, Riechers, Vieira, Hermes
U0C6	Ionized Nitrogen ([NII]) at High Redshift	Walter, Maiolino, Carilli, Riechers, Bertoldi, Weiss, Cox, Neri

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U0C7	Properties of the bright SMG MM1842 in the Early Universe	Lestrade, Combes, Salomé, Omont, Bertoldi, Neri, Krips, Kneib
U0C9	Mapping the brightest [CII] emitter at high-*z*	Maiolino, de Breuck, Martin Ruiz, Caselli, Nagao, Walmsley, Walter, Meneghetti
U0CE	An efficient programme for finding lensed star-forming galaxies at $z>4$	Krips, Cox, Dannerbauer, Eales, Omont, Beelen, Bertoldi, Dunne, Aretxaga, Hughes, Ivison, Cooray, Dye, Frayer, Negrello, Smail
U0D0	Clustered Massive Galaxy Formation around a z=5.3 Submillimeter Galaxy	Riechers, Carilli, Capak, Cox, Neri, Scoville, Bertoldi, Schinnerer
U0D5	The Star-Formation Rate Surface Density in a z=6.4 Quasar Host Galaxy	Riechers, Walter, Carilli, Wang, Neri, Bertoldi, Cox, Weiss
U0DE	Physics of Gas and Star Formation in Galaxies at z=1.2	Tacconi, Combes, Genzel, Bolatto, Bournaud, Burkert, Cooper, Cox, Davis, Förster Schreiber, García-Burillo, Graciá-Carpio, Lutz, Naab, Neri, Newman, Sternberg, Weiner
V--1	The nature of the unique source SWIFT 1644+57 (DDT-ToO)	Agudo, Castro-Tirado, Bremer, Winters, Gorosabel, Gómez, Guziy, de Ugarte Postigo, Castro Cerón, Sánchez-Ramirez, Tello
V--2	PdBI observations of the highest redshift HerMES submm galaxy at z=6.337	Perez-Fournon, Omont, Riechers, Bock, Bradford, Bridge, Clements, Cooray, Cox, Dowell, Farrah, Ferrero, Fu, Ivison, Neri, Oliver, Vieira, Wardlow, and the HERMES team
V--3	Constraining the redshift of HDF850.1	Walter, Carilli, Daddi, Cox, Riechers, Decarli, Bertoldi, Weiss, Neri, Menten, Dannerbauer, Bell, Dickinson, Ellis, Chiu, Krumholz, Robertson
V--4	Unveiling the afterglow and host galaxy of the dark GRB 110915A (DDT-ToO)	Castro-Tirado, Bremer, Winters, Gorosabel, Guziy, De Ugarte Postigo, Castro Cerón, Sánchez-Ramirez, Tello
V--5	Confirming the first high-*z* galaxy cluster detected with Planck	Dole, Nesvadba, Krips, Omont, Beelen, Montier, Puget, Christophe, Flores-Cacho, Lagache, Giard, Pointecouteau
V--6	Search for the C^+ line in the elusive submillimeter galaxy HDF850.1.	Walter, Carilli, Daddi, Cox, Riechers, Decarli, Bertoldi, Weiss, Neri, Menten, Dannerbauer, Bell, Dickinson, Ellis, Chiu, Krumholz, Robertson
V--7	A gamma-ray burst next door: GRB 111005A at 56.6 Mpc	Michalowski, Xu, Dannerbauer
V004	The HD34078 bow show: A benchmark for illuminated shock models?	Gratier, Boissé, Cabrit, Gerin, Lesaffre, Pety, Pineau des Forêts
V005	Search for the H_2CO photodesorption peak in the Horsehead PDR	Pety, Guzmán, Gerin, Goicoechea, Roueff
V006	HNCO: a new window to the protostellar environment	Rodriguez-Fernandez, Gueth, Lefloch, Guilloteau, Tafalla, Codella, Bachiller
V007	Revealing substructure in a very young starless core in the Pipe Nebula	Girart, Frau, Palau, Padovani, Morata, Beltrán, Estalella
V008	Dense gas structure and kinematics in a quiescent Infrared Dark Cloud	Henshaw, Caselli, Fontani, Jiménez-Serra, Tan, Butler
V009	Investigating shocks and infall motions toward W43-MM1 and MM2, two extreme star-forming sites created by converging flows	Nguyen-Luong, Motte, Bontemps, Schilke, Carlhoff, Simon, Schneider, Hill, Hennemann, Csengeri, Schuller, Menten, Wyrowski, Beuther, Henning, Maury, Gueth, Heitsch, Walmsley, Hennebelle, Banerjee, Kramer, Bronfman, Zavagno
V00B	Fragmentation and dynamics in ATLASGAL compact clumps	Csengeri, Wyrowski, Schuller, Bontemps, Menten, Pandian, Beuther, Troost, Wienen
V00C	A census of embedded cores in the active star-forming site, W51A - how well do class II methanol masers trace star-forming cores?	Csengeri, Wyrowski, Menten, Gueth, Leurini, Zapata
V00E	Catching the dense gas in the isolated high-mass YSO MDC1	Linz, Quanz, Beuther, Birkmann, Henning
V010	A Precise Measurement of the Deuteration of Water in Low-Mass Protostars	Persson, Jørgensen, van Dishoeck, Harsono
V012	The molecular counterpart of the HST jet in LkHα 233	Alonso-Albi, Fuente, Bachiller, Boissier, Neri, Codella, Lefloch
V013	CN and HCN in the disk around AB Aur	Fuente, Cernicharo, Neri, Goicoechea, Alonso-Albi, Berné, Agúndez, Fontani
V014	Vertical Stratification of Turbulence in Protoplanetary Disks I: CS mapping	Guilloteau, Dutrey, Henning, Wakelam, Hersant, Semenov, Chapillon, Launhardt, Piétu, Schreyer, Gueth
V015	Epsilon Aurigae - chasing the darkness	Bremer
V016	Masers and shocks in the gas around HVC stars	Quintana-Lacaci, Castro-Carrizo, Bujarrabal
V018	Small scale structure of the outer CO shells of IRC+10216	Guélin, Cernicharo, Agundez, Marcelino, Winters
V01A	Searching for the fossil disk around the first low-B magnetar	Rea, Girart, Isarel, Esposito, Palau, Perna
V01D	The Origin of the Nuclear Molecular Gas in M51a and AGN Feedback	Schinnerer, García-Burillo, Meier
V021	Physical conditions in the interstellar medium of early-type galaxies	Bureau, Topal, Bayet, Krips, Crocker, Young, Blitz, Combes, Davis, Alatalo, Cappellari, Emsellem, Krajnovic, McDermid, and the ATLAS^{3D} team
V025	Minkowski's Object: A case for positive AGN feedback?	Nesvadba, Boulanger, Salome, Lehnert, Pineau des Forets, Guillard, Boissier
V026	PdBI and Herschel: a dream team for the hunt ofmassive molecular outflows and negative feedback in active galaxies	Sturm, Maiolino, González-Alfonso, Graciá-Carpio, Hailey-Dunsheath, Davies, Veilleux, Fischer, Feruglio, Piconcelli, Fiore
V028	Massive molecular AGN-driven outflows: the cold vs warm components.	Dasyra, Combes, Salomé, Falgarone
V02B	The influence of the environment on cold gas in cluster galaxies	Jablonka, Combes, Rines, Finn
V02C	Fast molecular outflow in the young radio source 4C 32.44?	Orienti, Mack, Dallacasa
V02D	A robust and accurate measurement of the CMB temperature at z=0.89	Muller, Guélin, Aalto, Beelen, Black, Combes, Curran, Henkel, Horellou, Longmore
V02F	Probing the Interstellar Medium of High Redshift Seyfert Galaxies	Riechers, Wright, Ma, Daddi, Neri, Larkin
V031	Understanding the Origins of [CII] Emission in $z\sim1$-2 Quasars	Hailey-Dunsheath, Stacey, Nikola, Ferkinhoff

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V032	Molecular Gas in a Massive Elliptical Galaxy at z = 1.43	Sargent, Daddi, Onodera, Dannerbauer, Bournaud, Martig
V033	Molecular gas in intrinsically faint lensed z~2 galaxies	Lutz, Berta, Saintonge, Tacconi, Genzel, Magnelli, Baker, Popesso, Nordon
V034	Measuring the molecular gas in strongly lensed star-forming galaxies	Dessauges-Zavadsky, Combes, Omont, Boone, Schaerer, Zamojski, Blain, Egami, Rex, Richard, Kneib, and the HLS collaboration
V03C	Biased Star Formation in the Progenitors of Massive Cluster Ellipticals at *z*=2.5	Suzuki, Kohno, Tamura, Inoue, Ikarashi, Umehata, Nakanishi, Hatsukade, Kodama, Tanaka, Kajisawa, Wilson, Yun, Hughes, Aretxaga, Zeballos
V03E	High excitation lines of HCN and HCO^+ in the Cloverleaf quasar	Guélin, Riquelme, Neri, Kramer, García-Burillo, Winters, Zylka, Cox
V040	CI[492GHz] and CO(4-3) in z~2.3 SMGs - a joint PdBI/ALMA-ES project	Chapman, Weiss, Smail, Swinbank, Ivison, van der Werf, Alaghband-Zadeh
V041	Atomic carbon in a high-redshift obscured quasar	Martinez-Sansigre, Lacy, Schinnerer, Rawlings, Schumacher
V042	The quest for counterparts of sub-mm galaxies in the COSMOS field	Smolcic, Navarrete, Bertoldi, Salim, Albrecht, Karim, Riechers, Sheth, Schinnerer, Capak, Carilli
V043	Continuum imaging of the brightest mm sources from H-ATLAS	Bertoldi, Dannerbauer, Cox, Omont, Neri, Beelen, Negrello, Dunne, Verma, Ivison, Eales, Cooray, Glenn, Michalowski, van der Werf, Bussmann, Riechers, de Zotti, Ibar
V044	A search for molecular absorption at *z*=3	Nesvadba, Combes, García-Burillo, de Breuck, Boulanger, Lehnert, Papadopoulos
V045	Probing the Molecular Gas Reservoir of Normal Galaxies at z~3	Magdis, Dannerbauer, Daddi, Dickinson, Elbaz, Hwang, Rigopoulou, Sargent, Aussel, Burgarella, Coia, Koekemoer
V047	A search for winds and shocks in high-*z* quasars	Nesvadba, Polletta, Neri, Omont, Beelen, Lehnert, Bergeron, Boulanger, Pineau des Forêts, Papadopoulos
V048	Dense Molecular Gas Excitation in a z~4 AGN-Starburst Galaxy	Riechers, Weiss, Neri, Walter, Wagg, Cox, Downes
V04A	An efficient Program for Finding Lensed Galaxies at z>4 - II	Krips, Cox, Dannerbauer, Eales, Omont, Beelen, Bertoldi, Dunne, Aretxaga, Hughes, Ivison, Cooray, Dye, Frayer, Negrello, Smail
V04B	BR1202-0725: Gas, Dust and Star Formation Efficiency in a Merger at *z*=4.7	Guélin, Salome, Cox, Neri, Krips, Trippe, Guilloteau, Omont, Walter, García-Burillo
V04C	Molecular Gas Excitation and Environment of a *z*=5.3 Submillimeter Galaxy	Riechers, Carilli, Capak, Cox, Neri, Scoville, Schinnerer, Bertoldi
V04D	Molecular CO (6-5) line emission and molecular gas in the *z*=5.99 LoBAL quasar SDSS J2310+1855	Wang, Carilli, Walter, Neri, Fan, Bertoldi, Cox, Riechers, Omont, Menten, Strauss, Wagg, Jiang
V04E	Nature and Excitation of Submillimeter H_2O Emission at *z*=6.42	Riechers, Weiss, Walter, Neri, van der Werf, Cox, Carilli, Bertoldi, Wang, Omont, Maiolino
V04F	AGN feedback in the high redshift QSO J1148-5251 at *z*=6.4?	Weiss, Riechers, Walter, Carilli, Neri, Wang, Cox, Bertoldi, Maiolino
V050	Molecular Gas in a Spectroscopically Confirmed Quasar Host Galaxy at *z*=7.1	Venemans, Walter, Warren, McMahon, Mortlock, Hewett, Simpson
V059	The origin of molecules in protostellar jets: a pilot study of HH 111	Lefloch, Cabrit, Yvart, Gueth, Codella, Pineau des Forêts, Podio, Dougados
V06E	UY Aurigae: a prototypical circumbinary disk?	Piétu, Tang, Dutrey, Guilloteau, Di Folco, Boehler, Gueth, Beck, Barry, Simon
V07C	Dense Gas in M 33 - Complementary $^{12}CO(1-0)$ observations	Buchbender, Kramer, Quintana-Lacaci, Gonzalez-Garcia, Garcia-Burillo, Bertoldi, Anderl, Mookerjea, Braine, Gratier, Billot, Israel
V094	The nature of the unique source SWIFT J1644+57	Guziy, Agudo, Castro-Tirado, Bremer, Winters, Gorosabel, Gómez, Sánchez-Ramirez, Tello
V0B1	Exploring H_2O emission in high-*z* strongly lensed Herschel galaxies	Omont, van der Werf, Neri, Cox, Krips, Riechers, Harris, Weiss, Gavazzi, Baker, Bertoldi, Beelen, Clements, Cooray, Dannerbauer, Eales, Frayer, Guélin, Ivison, Lehnert, Lupu, Michalowski, Negrello, Leeuw
V0B2	A survey of ionized Nitrogen ([NII]) at high redshift.	Decarli, Walter, Maiolino, Carilli, Riechers, Bertoldi, Weiss, Cox, Neri
V0B4	Confirming a proto-cluster of galaxies in the Early Universe	Lestrade, Dannerbauer, Walter, Bertoldi
V0B6	Faint CO Emitters in the Hubble Deep Field North	Walter, Carilli, Daddi, Cox, Riechers, Decarli, da Cunha, Bertoldi, Weiss, Neri, Elbaz, Menten, Dannerbauer, Bell, Dickinson, Ellis, Chiu, Krumholz
V0B8	Comprehensive Study of an Exceptionally Bright Lensed SMG at z~4.6	Boone, Combes, Egami, Omont, Dessauges-Zavadsky, Schaerer, Richard, Kneib, Smail, Swinbank, Edge, Ivison, van der Werf, Rex, Rawle, Gurwell, Casey, Smith, Pham, Pello
V0B9	A first [CII] imaging survey of z>4 galaxies	Bertoldi, Knudsen, Walter, Riechers, Cox, Carilli, Wang, Maiolino, Omont, Weiss, Neri, Schinnerer
V0BD	A Detailed Investigation of the ISM in the Most Distant Starburst Galaxy	Riechers, Perez-Fournon, Omont, Cox, Bradford, Clements, Cooray, Wardlow, Neri, Krips, Dowell, Ivison, Conley, Vieira, Bock, Oliver
V0BE	Nature and Excitation of Submillimeter H_2O Emission at *z*=6.42	Riechers, Weiss, Walter, Neri, van der Werf, Cox, Carilli, Bertoldi, Wang, Omont, Maiolino
V0C0	Atomic and Molecular Gas in a Spectroscopically Confirmed Quasar Host Galaxy at *z*=7.1	Venemans, Walter, Decarli
V0C2	Unveiling the population of highly obscured and high-*z* gamma-ray bursts (ToO)	Castro-Tirado, Bremer, Winters, Gorosabel, Guziy, de Ugarte Postigo, Pérez-Ramírez, Castro Cerón, Tello, Sánchez-Ramírez

Annex III – Publications in 2011

The list of refereed publications, conferences and workshop papers as well as thesis based upon data obtained using the IRAM instruments are provided in the following two tables : the first table gives the publications with the IRAM staff members as co-author (including technical publications by the IRAM staff), and the second table those with results from the user's community.

The running number is the cumulative number since the first annual report was published for the year 1987.

2011 PUBLICATION LIST: IRAM COMMUNITY:

1568	Infall, outflow, and rotation in the G19.61-0.23 hot molecular core	Furuya R. S., Cesaroni R., Shinnaga H.	A&A 525, A72
1569	Multiwavelength VLBI observations of Sagittarius A*	Lu R.-S., Krichbaum T. P., Eckart A., König S., Kunneriath D., Witzel G., Witzel A., Zensus J. A.	A&A 525, A76
1570	Submillimeter absorption from SH, a new widespread interstellar radical, CH and HCl	Menten K. M., Wyrowski F., Belloche A., Güsten R., Dedes L., Müller H. S. P.	A&A 525, A77
1571	The tight correlation of CCH, and c-C_3H_2 in diffuse and translucent clouds	Gerin M., Kaźmierczak M., Jastrzebska M., Falgarone E., Hily-Blant P., Godard B., de Luca M.	A&A 525, A116
1572	The instrumental polarization of the Nasmyth focus polarimetric differential imager NAOS/CONICA (NACO) at the VLT. Implications for time-resolved polarimetric measurements of Sagittarius A*	Witzel G., Eckart A., Buchholz R. M., Zamaninasab M., Lenzen R., Schödel R., Araujo C., Sabha N., Bremer M., Karas V., Straubmeier C., Muzic K.	A&A 525, A130
1573	Mapping photodissociation and shocks in the vicinity of Sagittarius A*	Amo-Baladrón M. A., Martìn-Pintado J., Martìn S.	A&A 526, A54
1574	SiO outflows in high-mass star forming regions: A potential chemical clock?	López-Sepulcre A., Walmsley C. M., Cesaroni R., Codella C., Schuller F., Bronfman L., Carey S. J., Menten K. M., Molinari S., Noriega-Crespo A.	A&A 526, L2
1575	Water deuterium fractionation in the low-mass protostar NGC1333-IRAS2A	Liu F.-C., Parise B., Kristensen L., Visser R., van Dishoeck E. F., Güsten R.	A&A 527, A19
1576	Different evolutionary stages in the massive star-forming region S255 complex	Wang Y., Beuther H., Bik A., Vasyunina T., Jiang Z., Puga E., Linz H., Rodón J. A., Henning T., Tamura M.	A&A 527, A32
1577	Triggered star formation at the borders of the H II region Sh 2-217	Brand J., Massi F., Zavagno A., Deharveng L., Lefloch B.	A&A 527, A62
1578	Hunting for millimeter flares from magnetic reconnection in pre-main sequence spectroscopic binaries	Kóspál Á., Salter D. M., Hogerheijde M. R., Moór A., Blake G. A.	A&A 527, A96
1579	Gas dynamics in massive dense cores in Cygnus-X	Csengeri T., Bontemps S., Schneider N., Motte F., Dib S.	A&A 527, A135
1580	A survey of HC_3N in extragalactic sources. Is HC_3N a tracer of activity in ULIRGs?	Lindberg J. E., Aalto S., Costagliola F., Pérez-Beaupuits J.-P., Monje R., Muller S.	A&A 527, A150
1581	Shocked water in the Cepheus E protostellar outflow	Lefloch B., Cernicharo J., Pacheco S., Ceccarelli C.	A&A 527, L3
1582	A line-confusion limited millimeter survey of Orion KL. II. Silicon-bearing species	Tercero B., Vincent L., Cernicharo J., Viti S., Marcelino N.	A&A 528, A26
1583	Molecules as tracers of galaxy evolution: an EMIR survey. I. Presentation of the data and first results	Costagliola F., Aalto S., Rodriguez M. I., Muller S., Spoon H. W. W., Martìn S., Peréz-Torres M. A., Alberdi A., Lindberg J. E., Batejat F., Jütte E., van der Werf P., Lahuis F.	A&A 528, A30
1584	On the nature of faint mid-infrared sources in M 33	Corbelli E., Giovanardi C., Palla F., Verley S.	A&A 528, A116
1585	Galaxy evolution and star formation efficiency at $0.2<z<0.6$	Combes F., Garcìa-Burillo S., Braine J., Schinnerer E., Walter F., Colina L.	A&A 528, A124
1586	The puzzling deuteration of methanol in low- to high-mass protostars	Ratajczak A., Taquet V., Kahane C., Ceccarelli C., Faure A., Quirico E.	A&A 528, L13
1587	Molecular gas in NUclei of GAlaxies (NUGA). XV. Molecular gas kinematics in the inner 3 kpc of NGC 6951	van der Laan T. P. R., Schinnerer E., Boone F., Garcìa-Burillo S., Combes F., Haan S., Leon S., Hunt L., Baker A. J.	A&A 529, A45
1588	A molecular cloud within the light echo of V838 Monocerotis	Kamiński T., Tylenda R., Deguchi S.	A&A 529, A48
1589	High-angular resolution observations of methanol in the infrared dark cloud core G11.11-0.12P1	Gómez L., Wyrowski F., Pillai T., Leurini S., Menten K. M.	A&A 529, A161
1590	Probing the initial conditions of high-mass star formation. II. Fragmentation, stability, and chemistry towards high-mass star-forming regions G29.96-0.02 and G35.20-1.74	Pillai T., Kauffmann J., Wyrowski F., Hatchell J., Gibb A. G., Thompson M. A.	A&A 530, A118
1591	TIMASSS: the IRAS 16293-2422 millimeter and submillimeter spectral survey. I. Observations, calibration, and analysis of the line kinematics	Caux E., Kahane C., Castets A., Coutens A., Ceccarelli C., Bacmann A., Bisschop S., Bottinelli S., Comito C., Helmich F. P., Lefloch B., Parise B., Schilke P., Tielens A. G. G. M., van Dishoeck E., Vastel C., Wakelam V., Walters A.	A&A 532, A23
1592	Dense core formation by fragmentation of velocity-coherent filaments in L1517	Hacar A., Tafalla M.	A&A 533, A34
1593	Dissecting a hot molecular core: the case of G31.41+0.31	Cesaroni R., Beltrán M. T., Zhang Q., Beuther H., Fallscheer C.	A&A 533, A73
1594	Structure of the outer layers of cool standard stars	Dehaes S., Bauwens E., Decin L., Eriksson K., Raskin G., Butler B., Dowell C. D., Ali B., Blommaert J. A. D. L.	A&A 533, A107
1595	Molecular gas around low-luminosity AGN in late-type spirals	Böker T., Schinnerer E., Lisenfeld U.	A&A 534, A12

1596	Hydrogen cyanide and isocyanide in prestellar cores	Padovani M., Walmsley C. M., Tafalla M., Hily-Blant P., Pineau Des Forêts G.	A&A 534, A77
1597	The AMIGA sample of isolated galaxies. IX. Molecular gas properties	Lisenfeld U., Espada D., Verdes-Montenegro L., Kuno N., Leon S., Sabater J., Sato N., Sulentic J., Verley S., Yun M. S.	A&A 534, A102
1598	The formation of active protoclusters in the Aquila rift: a millimeter continuum view	Maury A. J., André P., Men'shchikov A., Könyves V., Bontemps S.	A&A 535, A77
1599	Carbon isotopic abundance ratios in S-type stars	Wallerstein G., Balick B., Alcolea J., Bujarrabal V., Vanture A. D.	A&A 535, A101
1600	Planck early results. XXII. The submillimetre properties of a sample of Galactic cold clumps	Planck Collaboration, Ade P. A. R., Aghanim N., Arnaud M., Ashdown M., Aumont J., Baccigalupi C., Balbi A., Banday A. J., Barreiro R. B., Bartlett J. G., Battaner E., Benabed K., Benoît A., Bernard J.-P., Bersanelli M., Bhatia R., Bock J. J., Bonaldi A., Bond J. R., Borrill J., Bouchet F. R., Boulanger F., Bucher M., Burigana C., Cabella P., Cantalupo C. M., Cardoso J.-F., Catalano A., Cayón L., Challinor A., Chamballu A., Chiang L.-Y., Christensen P. R., Clements D. L., Colombi S., Couchot F., Coulais A., Crill B. P., Cuttaia F., Danese L., Davies R. D., de Bernardis P., de Gasperis G., de Rosa A., de Zotti G., Delabrouille J., Delouis J.-M., Désert F.-X., Dickinson C., Doi Y., Donzelli S., Doré O., Dörl U., Douspis M., Dupac X., Efstathiou G., Enßlin T. A., Falgarone E., Finelli F., Forni O., Frailis M., Franceschi E., Galeotta S., Ganga K., Giard M., Giardino G., Giraud-Héraud Y., González-Nuevo J., Górski K. M., Gratton S., Gregorio A., Gruppuso A., Hansen F. K., Harrison D., Helou G., Henrot-Versillé S., Herranz D., Hildebrandt S. R., Hivon E., Hobson M., Holmes W. A., Hovest W., Hoyland R. J., Huffenberger K. M., Ikeda N., Jaffe A. H., Jones W. C., Juvela M., Keihänen E., Keskitalo R., Kisner T. S., Kitamura Y., Kneissl R., Knox L., Kurki-Suonio H., Lagache G., Lamarre J.-M., Lasenby A., Laureijs R. J., Lawrence C. R., Leach S., Leonardi R., Leroy C., Linden-Vørnle M., López-Caniego M., Lubin P. M., Macìas-Pérez J. F., MacTavish C. J., Maffei B., Malinen J., Mandolesi N., Mann R., Maris M., Marshall D. J., Martin P., Martìnez-González E., Masi S., Matarrese S., Matthai F., Mazzotta P., McGehee P., Melchiorri A., Mendes L., Mennella A., Meny C., Mitra S., Miville-Deschênes M.-A., Moneti A., Montier L., Morgante G., Mortlock D., Munshi D., Murphy A., Naselsky P., Nati F., Natoli P., Netterfield C. B., Nørgaard-Nielsen H. U., Noviello F., Novikov D., Novikov I., Osborne S., Pagani L., Pajot F., Paladini R., Pasian F., Patanchon G., Pelkonen V.-M., Perdereau O., Perotto L., Perrotta F., Piacentini F., Piat M., Plaszczynski S., Pointecouteau E., Polenta G., Ponthieu N., Poutanen T., Prézeau G., Prunet S., Puget J.-L., Reach W. T., Rebolo R., Reinecke M., Renault C., Ricciardi S., Riller T., Ristorcelli I., Rocha G., Rosset C., Rowan-Robinson M., Rubiño-Martìn J. A., Rusholme B., Sandri M., Santos D., Savini G., Scott D., Seiffert M. D., Smoot G. F., Starck J.-L., Stivoli F., Stolyarov V., Sudiwala R., Sygnet J.-F., Tauber J. A., Terenzi L., Toffolatti L., Tomasi M., Torre J.-P., Toth V., Tristram M., Tuovinen J., Umana G., Valenziano L., Vielva P., Villa F., Vittorio N., Wade L. A., Wandelt B. D., Ysard N., Yvon D., Zacchei A., Zonca A.	A&A 536, A22
1601	Molecular gas in the inner 0.7 kpc-radius ring of M 31	Melchior A.-L., Combes F.	A&A 536, A52
1602	A High-mass Dusty Disk Candidate: The Case of IRAS 18151-1208	Fallscheer C., Beuther H., Sauter J., Wolf S., Zhang Q.	ApJ 729, 66
1603	Spectroscopy of Luminous z>7 Galaxy Candidates and Sources of Contamination in z>7 Galaxy Searches	Capak P., Mobasher B., Scoville N. Z., McCracken H., Ilbert O., Salvato M., Menéndez-Delmestre K., Aussel H., Carilli C., Civano F., Elvis M., Giavalisco M., Jullo E., Kartaltepe J., Leauthaud A., Koekemoer A. M., Kneib J.-P., LeFloch E., Sanders D. B., Schinnerer E., Shioya Y., Shopbell P., Tanaguchi Y., Thompson D., Willott C. J.	ApJ 730, 68
1604	CARMA Survey Toward Infrared-bright Nearby Galaxies (STING): Molecular Gas Star Formation Law in NGC 4254	Rahman N., Bolatto A. D., Wong T., Leroy A. K., Walter F., Rosolowsky E., West A. A., Bigiel F., Ott J., Xue R., Herrera-Camus R., Jameson K., Blitz L., Vogel S. N.	ApJ 730, 72
1605	On the Evolution of the Molecular Gas Fraction of Star-Forming Galaxies	Geach J. E., Smail I., Moran S. M., MacArthur L. A., Lagos C. d. P., Edge A. C.	ApJ 730, L19
1606	The Redshift and Nature of AzTEC/COSMOS 1: A Starburst Galaxy at z = 4.6	Smolčić V., Capak P., Ilbert O., Blain A. W., Salvato M., Aretxaga I., Schinnerer E., Masters D., Morić I., Riechers D. A., Sheth K., Aravena M., Aussel H., Aguirre J., Berta S., Carilli C. L., Civano F., Fazio G., Huang J., Hughes D., Kartaltepe J., Koekemoer A. M., Kneib J.-P., LeFloc'h E., Lutz D., McCracken H., Mobasher B., Murphy E., Pozzi F., Riguccini L., Sanders D. B., Sargent M., Scott K. S., Scoville N. Z., Taniguchi Y., Thompson D., Willott C., Wilson G., Yun M.	ApJ 731, L27
1607	Discovery of an Active Galactic Nucleus Driven Molecular Outflow in the Local Early-type Galaxy NGC 1266	Alatalo K., Blitz L., Young L. M., Davis T. A., Bureau M., Lopez L. A., Cappellari M., Scott N., Shapiro K. L., Crocker A. F., Martìn S., Bois M., Bournaud F., Davies R. L., de Zeeuw P. T., Duc P.-A., Emsellem E., Falcón-Barroso J., Khochfar S., Krajnović D., Kuntschner H., Lablanche P.-Y., McDermid R. M., Morganti R., Naab T., Oosterloo T., Sarzi M., Serra P., Weijmans A.	ApJ 735, 88
1608	A Deep 1.2 mm Map of the Lockman Hole North Field	Lindner R. R., Baker A. J., Omont A., Beelen A., Owen F. N., Bertoldi F., Dole H., Fiolet N., Harris A. I., Ivison R. J., Lonsdale C. J., Lutz D., Polletta M.	ApJ 737, 83
1609	CO Observations of the Host Galaxy of GRB 000418 at z = 1.1	Hatsukade B., Kohno K., Endo A., Nakanishi K., Ohta K.	ApJ 738, 33
1610	A Multi-wavelength Study of the Star-forming Core Ahead of HH 80N	Masqué J. M., Osorio M., Girart J. M., Anglada G., Garay G., Estalella R., Calvet N., Beltrán M. T.	ApJ 738, 43
1611	Complex Molecules toward Low-mass Protostars: The Serpens Core	Öberg K. I., van der Marel N., Kristensen L. E., van Dishoeck E. F.	ApJ 740, 14
1612	Complex Structure in Class 0 Protostellar Envelopes. II. Kinematic Structure from Single-dish and Interferometric Molecular Line Mapping	Tobin J. J., Hartmann L., Chiang H.-F., Looney L. W., Bergin E. A., Chandler C. J., Masqué J. M., Maret S., Heitsch F.	ApJ 740, 45
1613	Supernova-enhanced Cosmic-Ray Ionization and Induced Chemistry in a Molecular Cloud of W51C	Ceccarelli C., Hily-Blant P., Montmerle T., Dubus G., Gallant Y., Fiasson A.	ApJ 740, L4
1614	Dust Properties and Disk Structure of Evolved Protoplanetary Disks in Cep OB2: Grain Growth, Settling, Gas and Dust Mass, and Inside-out Evolution	Sicilia-Aguilar A., Henning T., Dullemond C. P., Patel N., Juhász A., Bouwman J., Sturm B.	ApJ 742, 39
1615	The Ionization Fraction in the DM Tau Protoplanetary Disk	Öberg K. I., Qi C., Wilner D. J., Andrews S. M.	ApJ 743, 152
1616	The Enigmatic Core L1451-mm: A First Hydrostatic Core? Or a Hidden VeLLO?	Pineda J. E., Arce H. G., Schnee S., Goodman A. A., Bourke T., Foster J. B., Robitaille T., Tanner J., Kauffmann J., Tafalla M., Caselli P., Anglada G.	ApJ 743, 201

1617	Structure and Evolution of Debris Disks Around F-type Stars. I. Observations, Database, and Basic Evolutionary Aspects	Moór A., Pascucci I., Kóspál Á., Ábrahám P., Csengeri T., Kiss L. L., Apai D., Grady C., Henning T., Kiss C., Bayliss D., Juhász A., Kovács J., Szalai T.	ApJS 193, 4
1618	Molecular gas and star formation in early-type galaxies	Crocker A. F., Bureau M., Young L. M., Combes F.	MNRAS 410, 1197
1619	Origins of the extragalactic background at 1 mm from a combined analysis of the AzTEC and MAMBO data in GOODS-N	Penner K., Pope A., Chapin E. L., Greve T. R., Bertoldi F., Brodwin M., Chary R.-R., Conselice C. J., Coppin K., Giavalisco M., Hughes D. H., Ivison R. J., Perera T., Scott D., Scott K., Wilson G.	MNRAS 410, 2749
1620	The ATLAS project - IV. The molecular gas content of early-type galaxies	Young L. M., Bureau M., Davis T. A., Combes F., McDermid R. M., Alatalo K., Blitz L., Bois M., Bournaud F., Cappellari M., Davies R. L., de Zeeuw P. T., Emsellem E., Khochfar S., Krajnović D., Kuntschner H., Lablanche P.-Y., Morganti R., Naab T., Oosterloo T., Sarzi M., Scott N., Serra P., Weijmans A.-M.	MNRAS 414, 940
1621	The ATLAS project - V. The CO Tully-Fisher relation of early-type galaxies	Davis T. A., Bureau M., Young L. M., Alatalo K., Blitz L., Cappellari M., Scott N., Bois M., Bournaud F., Davies R. L., de Zeeuw P. T., Emsellem E., Khochfar S., Krajnović D., Kuntschner H., Lablanche P.-Y., McDermid R. M., Morganti R., Naab T., Oosterloo T., Sarzi M., Serra P., Weijmans A.-M.	MNRAS 414, 968
1622	A search for HeH^+ and CH in a high-redshift quasi-stellar object	Zinchenko I., Dubrovich V., Henkel C.	MNRAS 415, L78
1623	Minimal HCN emission from molecular clouds in M33	Rosolowsky E., Pineda J. E., Gao Y.	MNRAS 415, 1977
1624	The dynamics of the ionized and molecular interstellar medium in powerful obscured quasars at $z \geq 3.5$	Nesvadba N. P. H., Polletta M., Lehnert M. D., Bergeron J., De Breuck C., Lagache G., Omont A.	MNRAS 415, 2359
1625	Multiwavelength observations of cirrus clouds in the North Celestial Loop: physical parameters of molecular sites	Barriault L., Joncas G., Plume R.	MNRAS 416, 1250
1626	On the absence of molecular absorption in high-redshift millimetre-band searches	Curran S. J., Whiting M. T., Combes F., Kuno N., Francis P., Nakai N., Webb J. K., Murphy M. T., Wiklind T.	MNRAS 416, 2143
1627	Confirmation of the VeLLO L1148-IRS: star formation at very low (column) density	Kauffmann J., Bertoldi F., Bourke T. L., Myers P. C., Lee C. W., Huard T. L.	MNRAS 416, 2341
1628	The ATLAS project - X. On the origin of the molecular and ionized gas in early-type galaxies	Davis T. A., Alatalo K., Sarzi M., Bureau M., Young L. M., Blitz L., Serra P., Crocker A. F., Krajnović D., McDermid R. M., Bois M., Bournaud F., Cappellari M., Davies R. L., Duc P.-A., de Zeeuw P. T., Emsellem E., Khochfar S., Kuntschner H., Lablanche P.-Y., Morganti R., Naab T., Oosterloo T., Scott N., Weijmans A.-M.	MNRAS 417, 882
1629	Dense molecular gas in nearby gas-rich active galaxies	Jiang X., Wang J., Gu Q.	MNRAS 418, 1753
1630	Molecules in protostellar shocks: the CHESS view on L1157-B1	Lefloch B., Benedettini M., Cabrit S., Caux E., Ceccarelli C., Cernicharo J., Codella C., Giannini T., Nisini B., Parise B., Salez M., Vasta M., Viti S., CHESS Team	IAU Symp. 280, 8
1631	Line surveys of evolved stars	Cernicharo J.	IAU Symp. 280, 20
1632	SO and SO_2 line observations and chemical evolution of Orion KL	Esplugues G. B., Cernicharo J., Viti S., Tercero B., Marcelino N., Goicoechea J. R.	IAU Symp. 280, 88
1633	Probing the physical conditions in Orion KL with methyl cyanide	Bell T. A., Cernicharo J., Herschel Hexos Team	IAU Symp. 280, 90
1634	DR21(OH) - a high-mass star cluster in formation observed with Herschel-HIFI, and the IRAM PdBI	Bontemps S., Csengeri T., Herpin F., Schneider N., Motte F., Chavarria L., Baudry A.	IAU Symp 280, 100
1635	Analysis of velocity components along the line of side towards SgrB2(M)	Buchel D., Schilke P., Comito C., Qin S. L., Bergin E. A., Lis D. C.	IAU Symp. 280, 109
1636	Study of deuterated water in the low-mass protostar IRAS16293-2422	Coutens A., Vastel C., Caux E., Ceccarelli C., Herschel Chess Team	IAU Symp. 280, 139
1637	HNC in the C-rich envelope of the AGB star IRC+10216	Daniel F., Agundez M., de Beck E., Cernicharo J., Decin L., Lombaert R.	IAU Symp. 280, 145
1638	The Molecular UCHII Region W31C seen by Herschel-HIFI	de Luca M., Bell T. A., Coutens A., Gerin M., Gupta H., Monje R., Mookerjea B., Vastel C.,	IAU Symp. 280, 146
1639	Chemical differentiation in magnetized young starless cores in the Pipe Nebula	Frau P., Girart J. M., Beltran M. T., Morata O.	IAU Symp. 280, 162
1640	Large-scale molecular shocks in galaxies: the imprint of mechanical dominated regions (MDR)	Garcia-Burillo S., Usero A., Fuente A., Gracia-Carpio J., Baker A. J., Martin-Pintado J.	IAU Symp. 280, 170
1641	A millimeter spectral survey of the Orion Bar Photo Dissociation Region	Goicoechea J. R., Cuadrado S., Fuente A., Esplugues G. B., Cernicharo J., Garcia-Burillo S., Usero A., Marcelino N.	IAU Symp. 280, 180
1642	SiO outflows in high-mass star forming regions: a potential chemical clock	Lopez-Sepulcre A., Walmsley M., Cesaroni R., Codella C., Schuller F., Bronfman L., Carey S. J., Menten K., Molinari S., Noriega-Crespo A.	IAU Symp. 280, 241
1643	Investigating the molecular content of lensed submillimeter galaxies	Lupu R., Z-Spec Team	IAU Symp. 280, 242
1644	Large Scale CO Emission in Orion A: Star Formation Feedback on the Molecular Gas	Marcelino N., Berné O., Cernicharo J.	IAU Symp. 280, 246
1645	Warm Deuteration of Hydrogen Cyanide in Orion	Marcelino N., Tercero B., Cernicharo J., Roueff E., Palau A., Goicoechea J. R., Herschel HEXOS Team	IAU Symp. 280, 247
1646	The quest for complex molecules in space. Searches for cyanides related to n-propyl cyanide in Sgr B2(N)	Muller H. S. P., Belloche A., Menten K. M., Coutens A., Walters A., Grabow J. U., Schlemmer S.	IAU Symp. 280, 269
1647	Molecular Complexity in the Cep E protostellar Outflow	Pacheco Vazquez S., Lefloch B., Ceccarelli C.	IAU Symp. 280, 281
1648	Acetone in Orion: high-resolution images of a special oxygen-bearing molecule	Peng T. C., Brouillet N., Favre C., Despois D., Baudry A., Remijan A., Wilson T., Wootten A.	IAU Symp. 280, 291
1649	Molecular complexity in O-rich circumstellar envelopes around evolved stars: IK TAU and OH 231.8+4.2	Sanchez Contreras C., Velilla Prieto L., Cernicharo J., Alcolea J., Pardo J. R., Agundez M., Bujarrabal V., Herpin F., Menten K. M., Wyrowsky F.	IAU Symp. 280, 327

1650	Global collapse of the DR21 filament	Schneider N., Csengeri T., Bontemps S., Motte F., Simon R., Hennebelle P., Federrath C., Klessen R.	IAU Symp. 280, 336
1651	A line confusion limited millimeter survey of Orion KL	Tercero B., Cernicharo J., Pardo J. R., Goicoechea J. R.	IAU Symp. 280, 350
1652	Herschel observations of extra-ordinary sources: Sulfur carbon chains and silicon bearing species in Orion KL	Tercero B., Cernicharo J., Marcelino N., Herschel HEXOS Team	IAU Symp. 280, 351
1653	Complex organic molecules toward low-mass protostars and outflows	van der Marel N., Oberg K. I., Kristensen L., van Dishoeck E. F.	IAU Symp. 280, 365
1654	An expanding disk around the young massive star AFGL 2591	Wang K. S., van der Tak F., Hogerheijde M.	IAU Symp. 280, 381
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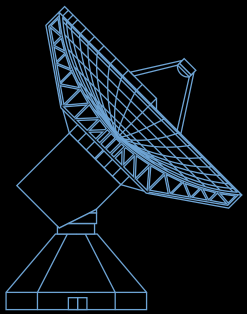
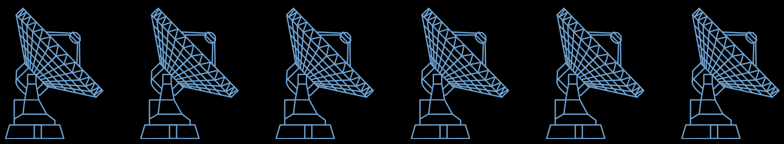


30-meter diameter telescope, Pico Veleta



6 x 15-meter interferometer, Plateau de Bure

The Institut de Radioastronomie Millimétrique (IRAM) is a multi-national scientific institute covering all aspects of radio astronomy at millimeter wavelengths: the operation of two high-altitude observatories – a 30-meter diameter telescope on Pico Veleta in the Sierra Nevada (southern Spain), and an interferometer of six 15 meter diameter telescopes on the Plateau de Bure in the French Alps – the development of telescopes and instrumentation, radio astronomical observations and their interpretation.

IRAM was founded in 1979 by two national research organizations: the CNRS and the Max-Planck-Gesellschaft – the Spanish Instituto Geográfico Nacional, initially an associate member, became a full member in 1990.

The technical and scientific staff of IRAM develops instrumentation and software for the specific needs of millimeter radioastronomy and for the benefit of the astronomical community. IRAM's laboratories also supply devices to several European partners, including for the ALMA project.

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